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ABSTRACT

Designed for junior high school students, this curriculum on marine science careers contains instructional materials on oceanography and related careers suitable for individualized study. The curriculum is organized into a study-direction book (included in this document) and a separate answer-response book (see CE 010 396). The text is divided into the following eleven chapters: (1) Global Landmarks; (2) The Navigator; (3) Charting the "Hidden Lands"; (4) Charting the Water's Flow; (5) Marine Careers; (6) What is the Ocean's Greatest Natural Resource?; (7) What Life is there in the Ocean? (8) A Field Trip to Sandy Hook, New Jersey; (9) Investigation of Field-Trip Specimens; (10) There Are Decisions to Be Made; and (11) Art from the Sea and Beach. Short quizzes are at the end of each chapter for the student's self-evaluation. Each chapter also includes objectives, equipment needed, references, resource materials, content information, learning activities, and questions to ponder. The following information is appended: colleges and universities offering training in oceanography; addresses of professional and trade organizations concerned with marine science; and addresses of related government offices. (BM)

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State of New Jersey
Department of Education
Division of Vocational Education
and Career Preparation

MARINE SCIENCE CAREERS

for the Junior High School Student

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Township of Ocean Junior High School

Photographs by Charles A. Burrus, Jr.

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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"The ocean is more than a curisoity. Our very survival may depend on it."

John F. Kennedy, President, 1960.

Preface

Today there is a sense of urgency when studying the oceans.

When Sir Edmund Hillary was asked why he climbed Mount Everest, he replied, "Because it was there." The oceans are being studied today because *they are there* and more, because *we must*!

Our continental land masses, approximately 30 percent of the surface of the earth, are not supporting the almost four billions of people populating the earth. We must use the resources of the sea, and we must know how to *use the ocean wisely* and *not destroy it.*

The great expanse of the sea is being threatened in all areas: coastlines, surface, and bottom.

As Governor of New Jersey, Brendan T. Byrne espressed his concern for the wetlands of his state:

> Although New Jersey is a small state, we have thousands of acres of tidal marsh within our borders. These wetlands represent an invaluable natural resource for all of us. Esthetically the marshes provide a welcome relief to the spreading metropolis. A variety of wild flowers bloom there and other kinds of plant life abound. Many species of shore birds and water fowl nest on the mud flats. Also various kinds of fish spawn in the shoal areas of the marsh.
>
> In a larger sense, the wetlands play a vital role in the eco-system of our state. The presence of this vast marshy region serves as a natural barrier against the ravishes of floods. The wetlands help to clear and replenish our waterways, and the green plants of the marsh give off atmosphere-purifying oxygen.
>
> Over the years, civilization has made serious inroads into the wetlands, which threaten the integrity of the region. In many instances, building has been haphazard and unplanned. Unsightly development detracts from the natural beauty of the marsh. Large piles of garbage pollute the waterways and foul the air. In the wetlands, planning has traditionally taken a back seat to expediency.
>
> Recently, however, there has been increased public awareness of the problems of the area. People are beginning to realize the need to protect the marsh. I am encouraged by the example of the Hackensack Meadowlands Commission, which has developed a forward-looking master plan for a large portion of the northern New Jersey meadowlands. One social planner has called land-use planning "...the most important domestic issue for the seventies." In New Jersey, I think we have done much to meet the challenge of our time.

However, there is much that is left undone, and threats to the marsh environment still are very much with us. I find particularly distressing the proposal of the Federal Government to lease oil-drilling rights off the New Jersey coast. This exploration could stimulate on-shore construction which would have dire consequences for our wetland areas. I wholeheartedly endorse the goals of your program because I think that an informed and enroused citizenry can do much to protect our marshlands from exploitation.

YOU are becoming an *"informed citizenry"*! Will you become an *"aroused citizenry"*?

To The Student

Your study of the ocean will use many scientific fields to explore the marine environment: physics, geology, chemistry, biology, meterology, and geography.

At the same time you are studying the ocean you will be investigating *careers* which relate to Oceanography. There is an expanding need for scientists, teachers, engineers, conservationists, technicians, and those with varied skills for the many support systems investigating the inner spaces of our planet.

Our planet Earth needs well-trained men and women to investigate, preserve, and use the resources of the sea wisely for the benefit of all people everywhere.

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By Charles A. Burrus, Jr.

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Chapter I: Global Landmarks

Chapter Emphasis: Geography review leading to the concept that the oceans are one.

Objectives:

1. Given the latitude and longitude, the student is able to identify a specific location.
2. Given a specific location, the student will be able to identify its latitude and longitude.
3. Given a globe, the students will be able to identify the hemispheres and name the continents and oceans in them.
4. Given a globe or map, students will be able to trace alternate round-the-world water routes.
5. Students will be able to list major oceans and the characteristics of each.
6. (Optional) Given sufficient information, the student will be able to compute the number of miles in each degree of latitude.

After reviewing global geography, the student should be "at home" with the surface of the earth, becoming increasingly aware of the vast amount of water covering it. This should set the stage for appreciating the need to know more about this two-thirds of the earth's surface and for developing an interest in the careers involved in the pursuit of oceangraphy.

Equipment:

Globes of the earth. Maps may be substituted if necessary.
Compasses (optional)

References:

1. *This Great and Wide Sea,* R.D. Coker. Harper and Row, New York. 1947.
2. *Globe Studies and Uses,* S.W. Boggs and F.K. Branon. A. J. Nystrom and Co., Chicago, Illinois. 1954.
3. *Questions About the Oceans,* publication G-13, Harold W. Dubach and Robert W. Taber. U.S. Naval Oceanographic Office, Washington, D.C. 20390. 1969.

4. *Oceanography, A View of the Earth*, M. Grant Gross. Prentice-Hall, Englewood Cliffs, New Jersey. 1972.

5. *Water, Our Most Valuable Resource*, Ivah Green Coward. McCann, Inc., New York, New York. 1958.

Charts:

Oceanography Chart. A colorful wall chart that includes charts, pictures, tables of information, and glossary of terms. 38½" x 29½". ($3.50)
Roy G. Scarfe, Inc., P.O. Box 217, Thorndale, Pa. 19372.

Chapter I
Global Landmarks

The oceans, mid-ocean ridges, deep-sea trenches, and currents will be easy to find if you first become "at home" with a globe or world map. We all appreciate familiar landmarks when we travel.

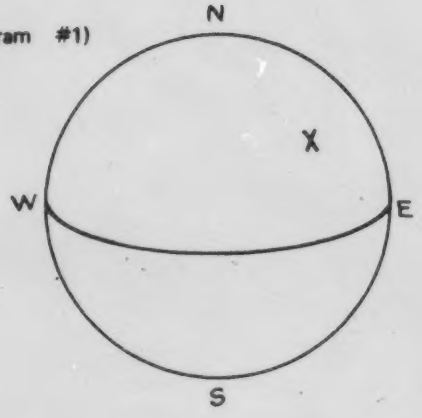
Have you ever met someone in a large city? You need directions and landmarks!

"I'll meet you in New York City on the northwest corner of Fifth Avenue and 59th Street at 3:00 p.m. on June 26."

These are specific directions. Can global geography be as specific?

(A) X Marks the Spot!

(Diagram #1)



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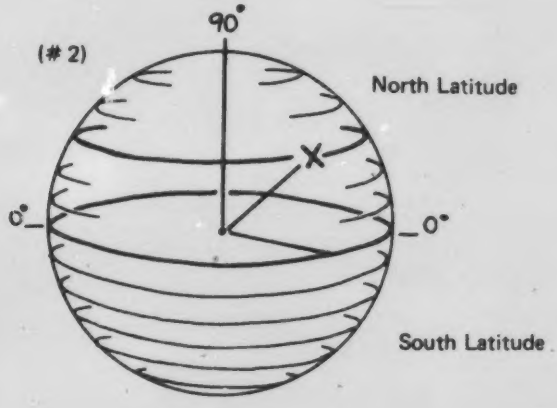


Look at diagram #1. With only the information given to you, describe the location of "X". (1-1)*

A line is drawn from east to west around the earth halfway between the North and South Poles. What is this imaginary line called? (1-2)

In diagram #2, lines have been drawn east to west parallel to each other. These lines are also parallel to the equator. What is another name for these "parallels"? (1-3)

* Enter your answer next to 1-1 in your answer book (green pages).

How many degrees (follow the imaginary angle on diagram #2) are there from the equator to the North Pole? (1-4)

Diagram #2 shows six equal distances defined by each parallel. In this case, how many degrees are there between parallels? (1-5)

Now, where is the X? Be as specific as you can with the information you have. (1-6)

(Your description is still rather indefinite, though.)

(Diagram #3)

Refer to Diagram #3. The heavy north-south line really extends around the earth, running through Greenwich, England, and through the poles. This is called the **prime meridian** and is marked zero degrees. Lines to the east and west of the prime meridian are 30 degrees apart on this diagram, meeting at the poles. Another name for the meridians is (1-7) lines. The **international dateline** is half-way around the globe from the prime meridian. How many degrees east or west from the prime meridian is the international dateline? (1-8)

Now the X is on or near a meridian, and it is a number of degrees east or west of the prime meridian. Describe its location now in terms of latitude and longitude. (1-9)

(B) Sea and Land

You will need a globe. Use it with a partner unless there are not enough globes for this. Then use them in groups of four.

1. **Western Hemisphere**: Hold the globe at arm's length so that you look at the equator at eye level. Rotate the globe so that the 110th meridian west is centered in front of you. You are now looking at the **Western Hemisphere**.

   What continents are in the Western Hemisphere? (1-10)

   What oceans? (1-11)

   Why is the Western Hemisphere called the New World? (1-12)

2. **Eastern Hemisphere**: Rotate the globe, keeping the equator at eye level. Center the 70th meridian east, and you will be looking at the **Eastern Hemisphere**.

   What continents are in the Eastern Hemisphere? (1-13)
   What oceans? (1-14)
   Which has more land, the Eastern Hemisphere or the Western Hemisphere? (1-15)
   Why is the Eastern Hemisphere called the Old World (1-16)

3. **Northern Hemisphere**: The equator also divides the earth into two hemispheres: the Northern Hemisphere and the Southern Hemisphere. Place the globe on the floor and look directly down on the North Pole. You are now looking at the **Northern Hemisphere.**

   What continents are in the Northern Hemisphere? (1-17)
   What oceans? (1-18)
   Is the North Pole on water or land? (1-19)
   What ocean is at the North Pole? (1-20)

4. **Southern Hemisphere**: Raise the globe so that you are looking at the South Pole. Now you can see the **Southern Hemisphere.**

   What ocean is near the South Pole? (1-21)
   Is the South Pole on land? (1-22)
   What continents are in the Southern Hemisphere? (1-23)
   What oceans? (1-24)
   Is there more land or water in the Southern Hemisphere? (1-25)
   What continent is at the South Pole? (1-26)

5. **Land Hemisphere**: Place the globe so that your eyes are level with the British Isles. You are looking at the **Land Hemisphere.**

   Name the continents which are in the land hemisphere. (1-27)
   Name the oceans. (1-28)

6. **Water Hemisphere:** Place the globe so that your eyes are level with New Zealand. You are looking at the **Water Hemisphere.**

What continents are in the Water Hemisphere? (1-29)
What oceans? (1-30)

You have looked at six hemispheres. You have made observations. Now write your conclusions about the distribution of land masses and major bodies of water. (1-31)

(C) More About the Earth

This is an optional exercise. You will need a compass and metric ruler for this study.

Draw a circle with the radius of 4 cm in your answer book. (This circle represents the earth.)
What is the diameter of your circle? (Remember that 2 radii equal the diameter.)
Draw the diameter on your circle. This diameter represents the equator of the earth. If 1 cm equals 1000 miles on this scaled drawing, what is the diameter of the earth?

The circumference of a circle equals π or 3.14 times the diameter. What is the circumference of the earth? Check this answer with your teacher. Now round off your answer to the nearest thousand miles.

We know there are 360 degrees in a circle. With the information you have, how many miles (in round numbers) are in each degree of longitude at the equator?

Since our earth is almost a perfect sphere, you must know that each degree of latitude anywhere on the earth has the same number of miles in it as are in a degree longitude at the equator. How many miles north of the equator is 40° north latitude?

(D) Earth, the Water Planet

Early literature talks about the "seven seas." The major oceans are not actually seven in number but are geographically divided into seven areas. Two oceans are divided into north and south portions, and one is not always classified as a separate ocean. It is more a convenient geographical reference. With this information and a globe or map for reference, list the seven major oceans. (1-32)

As there are "seven seas," there are also seven major land masses. List the seven continents in your answer book. (1-33)
Which is the largest ocean? (1-34) Did you know that it covers one-third of the earth's surface?
What is your estimate of how much of the earth's surface is covered with water? (1-35)

If we compare the several great oceans we'll find that each has its characteristic features. The Atlantic and Indian oceans are not greatly different in size, but their shapes show marked contrasts. The Atlantic is long in the north-south direction, and is almost cut in two by two prominent bulges of land masses. What are the two continents protruding into the Atlantic Ocean? (1-36)

H.A. Marmer in his book "The Sea" brings our attention to the coastlines of the great oceans. "The Atlantic, which extends into the land masses in so many places and so deeply, that although it has only about one-fifth the combined area of the Pacific and Indian oceans, it has a longer coastline than these two oceans taken together."

It is not by accident alone that the great populations and great developments have been realized in the north temperate zone, around the North Atlantic, and, originally, on the western side of the North Pacific.

(E) Are the Oceans Interrelated?

Problem: Plan a round-the world trip, beginning and ending in New York City.

Your route will be only on water. Do *not* cross any land areas! List the oceans, straits, bays, etc. that you will cover. Be specific, so your directions can be followed. (1-37). Also mark your route with arrows.

After completing the above assignment, choose an alternate route and complete the same tasks as above. (1-38)

Do you see the importance of the Suez Canal?

You now know that the seven major oceans are really one. Approximately 70 percent of the earth's surface is covered by this continuous body of water. One ocean affects another. It is an interesting thought that the water we might swim in off the New Jersey shore may have wet the toe of a South Sea Islander, or may have been in the atmosphere at one time and rained on a country in southern Africa thousands of years ago!

The Earth as Seen From the Apollo 17 Spaceship

(F) Questions To Ponder

1. When did the science of **Oceanography** begin?
2. The story of **Atlantis** is one of the most persistent of all legends. What is **Atlantis**?
3. How did the **Black Sea, Red Sea,** and **Yellow Sea** get their names?
4. How thick is the ice in the Arctic Ocean?
5. What is the volume of the world's oceans?
6. Are radioactive wastes disposed of in the ocean? If so, where and how and are there any dangers involved?
7. If all the world's ice suddenly melted, how high would the level of the sea rise?
8. Gold worth millions of dollars lies on the bottom of the ocean. Has anyone or any country ever mined this gold?
9. Why is the ocean blue?

(G) Self Evaluation

1. (a) In terms of longitude, what is the location of Greenwich, England?

   (b) A point on the Arctic Circle would be how many degrees north latitude?

   (c) The center of what continent is about 105° west of Greenwich, England?

   (d) Describe the location at 45° east longitude and 20° south latitude.

2. Give specific examples illustrating the earth's uneven distribution of land and water masses.

3. Is the following statement true or false? Give reasons for your answer. "What happens in the Atlantic Ocean cannot be understood without considering what takes place in the Antarctic Ocean, nor those of the Antarctic without reference to the Pacific and Indian Oceans."

4. What percentage of the earth's surface do the oceans cover?

5. What ocean is to the west of Europe?

6. There are no boundaries around the Antarctic Ocean. What oceans merge into the Antarctic area?

7. What land masses separate the Atlantic Ocean from the Pacific Ocean?

Chapter II: The Navigator

Chapter Emphasis: To acquaint the student with some tools of the navigator and the use of each.

Objectives:

1. Given a nautical chart, students will be able to identify the necessary navigational information, such as:
   a. Shallow or deep water
   b. Navigational hazards
   c. Buoys and their significance

2. Given a magnetic bearing, students will be able to compute the true bearing, knowing the area's magnetic variation.

3. Given the proper material, students will be able to construct a simple star sighter, an astrolabe.

4. Given an astrolabe, students will be able to compute the latitude of the area by sighting the North Star, Polaris.

Equipment:

Class set of small compasses	Protractors
Bar magnets	Straws
Iron filings	Tape
	String
	Weights

A sky chart of the Northern Hemisphere will be helpful.

References:

1. *Laboratory Manual, Basic Earth Science,* by Ploutz, Lambert and Decker. The L.W. Singer Company, Syracuse, New York. 1964.

2. *New England and the Sea,* Thayer Shafer, editor. University of Rhode Island Marine Bulletin Series No. 11. 1973.

3. *Seas, Maps, and Men: An Atlas History of Man's Exploration of the Oceans,* P. Hamlyn. Geographical Projects Limited, London, England. 1962.

4. *Piloting, Seamanship and Small Boat Handling,* Charles F. Chapman. Hearst Corporation, New York, N. Y. 1971.

5. *The Sea Around Us* – Special Edition for Young Readers, by Rachel Carson. Golden Press. New York, N. Y. 1968.

6. *Chartwork for Fishermen and Boat Operators*, G.A. Motte. URI Marine Advisory Service, Narragansett, R. I. 1973.

7. *Navigation for Fishermen and Boat Operators*, G.A. Motte. URI Marine Advisory Service, Narragansett, R. I. 1973.

The State of New Jersey offers a **Basic Boatman's Safety Course** geared to the middle grades: six through eight. This is a one-week course, approximately one hour per day, taught by one of the New Jersey Marine Police. For further information contact New Jersey Marine Police, P. O. Box 1889, Trenton, N. J. 08625

Nautical charts may be purchased at most large marine-supply firms. Nautical catalogs and charts can be ordered directly from: U.S. Department of Commerce, Distribution Division C44, National Ocean Survey, Washington, D.C. 20235. There is no charge for the catalogs.

Films:

1. "To Help Man Find His Way," Modern Talking Pictures. 1212 Avenue of Americas, New York N.Y. 10036. 28 min. color.

2. "Modern Geodetic Survey," Navy Film NO. MN10203. Write to Assistant for Public Affairs of your local naval district office. 16 mm., 22 min. color.

3. "The Shape of the Earth," McGraw-Hill text films, 330 West 42nd Street, New York, N.Y. 10036. 16 mm., 28 min. color.

(A) Training Chart

A navigator must know the ocean's "landmarks." The visible landmarks on the ocean are buoys and shore-based structures, such as lighthouses and other prominent features. The buoys have special characteristics such as shape, color, number, and light or sound that give the navigator information as to how to proceed.

Procedure:

In this activity you will work with a training chart. On the back of the chart you will find an explanation of the symbols used, and these will enable you to answer the questions.

Method:

Using a Coast and Geodetic Survey nautical chart, answer the following questions in your answer book.

2-1. What color is land which is permanently above water?
2-2. What color is land which is exposed at low tide?
2-3. What color is used to indicate relatively shallow water?
2-4. What color is used to indicate deeper water?
2-5. In what units is the depth of water shown?
2-6. What is the scale used in making this chart?
2-7. Explain what scale means.
2-8. What is the usual color of nun buoys? How are they numbered?
2-9. What is the usual color of can buoys? How are they numbered?
2-10. Examine the entrance to a harbor. What do you notice about the arrangement of the buoys which mark the channel?
2-11. In the space provided in the answer book, make a sketch showing the actual appearance of nun and can buoys.

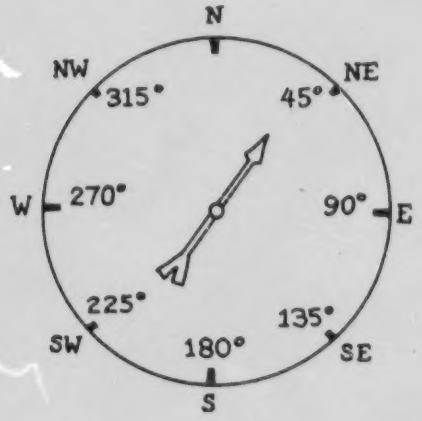
(B) The Magnetic Compass

One of the oldest and yet one of the most useful tools of the navigator is the magnetic compass. It is thought that the ancient Chinese built compasses for navigation out of natural lodestones. By the 12th century, compasses were in use in Europe.

Because the compass pointer points to the north, by rotating the scale beneath the pointer it is possible to tell the direction that the ship is sailing.

Directions on the compass are described in terms of degrees, based upon the 360 degrees of the cirle. Thus:

360° (or 0°)	North
90°	East
180°	South
270°	West

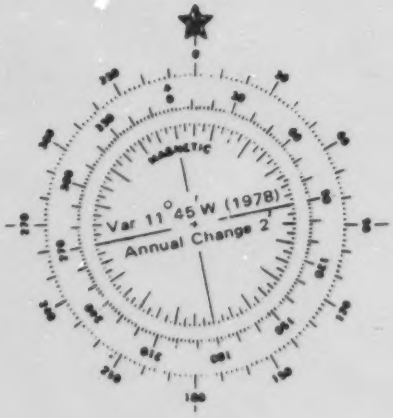


The compass pointer is attracted by the north (or south) magnetic pole. However, these magnetic poles are not located in the same positions as the geographic or "true" poles. Since the longitude lines used on charts and maps are laid out from the geographic poles, it can be seen that a line drawn on such a chart in a direction indicated by a compass will not be accurate. The difference between the true and magnetic directions is called the **variation.**

Variation is the angle between true north and magnetic north; it is expressed in degrees. Variation is different all around the earth, and it is also changing very slowly.

In the area of New Jersey, variation is about 12° W. This means that the compass is pulled away from true north in the amount of 12° to the west. If variation is west you must *add* the appropriate number of degrees to any magnetic or compass reading to get the true direction. (If variation is east you must *subtract* the appropriate number of degres from compass reading).

Modern chart "rose" shows the relationship between magnetic and true north.



Method:

On the basis of the previous information, fill in the following in your answer book.

TRUE BEARING	VARIATION	MAGNETIC BEARING
150°	15°W	
	15°W	270°
90°		75°
	5°E	180°
220°	5°E	
65°		72°

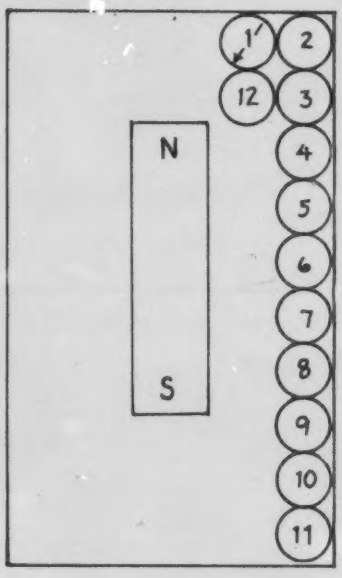
Investigation: The Magnetic Compass

1. Place a bar magnet *on top* of a sheet of plain white paper, as shown in the diagram. Position your small compass in the locations indicated and in the order suggested. After the compass needle has come to rest, make a mark at both ends of the needle. After removing the compass, connect the marks. After all the marks have been connected in pairs, see if you can find a pattern in which several of the marks can be connected head-to-tail to form an overall geometric pattern.

2. Now place your magnet *under* your sheet of paper as shown in the diagram. Carefully sprinkle a small quantity of iron filings on the paper. Compare the pattern that they form with the lines you drew in No. 1.

1

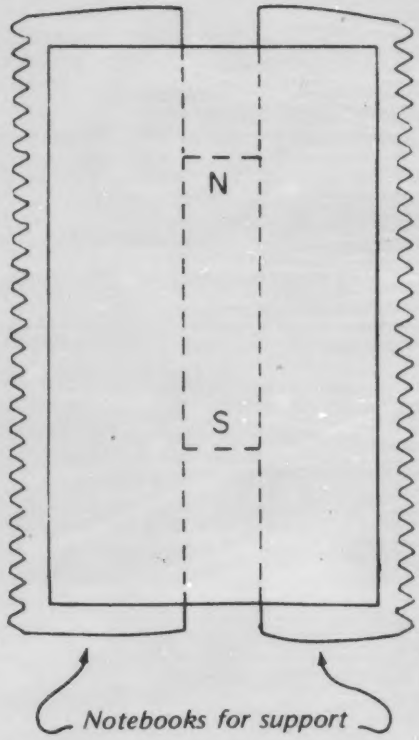
(Magnet on top)



(Note! You may not be able to fit your compass in as many locations as indicated. Follow the pattern nonetheless.)

2

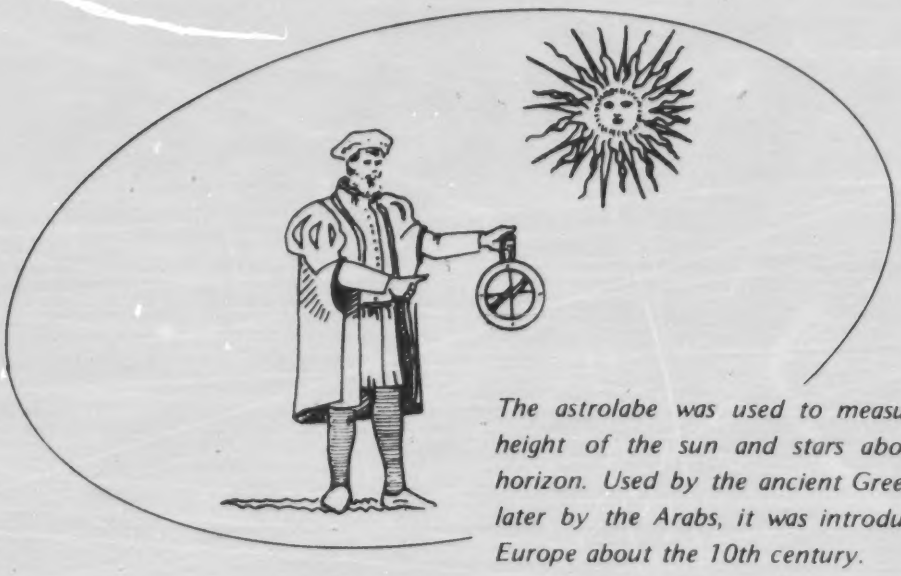
(Magnet underneath)



(C) The Astrolabe

Early mariners observed the position of stars and kept records. They observed that as a ship sailed north, the North Star appeared higher in the sky, while other stars crossed the sky. By using the North Star, sailors in the Northern Hemisphere found that they could determine their latitude. (Remember, latitude is the distance north or south of the equator.)

Today we are in an age of instantaneous electronic navigation with such instruments as radar, sonar, loran, inertial guidance systems, and statellite navigators. With accurate charts, depth finder and radio-direction finder, the position of any boat can quickly be located by its operator.



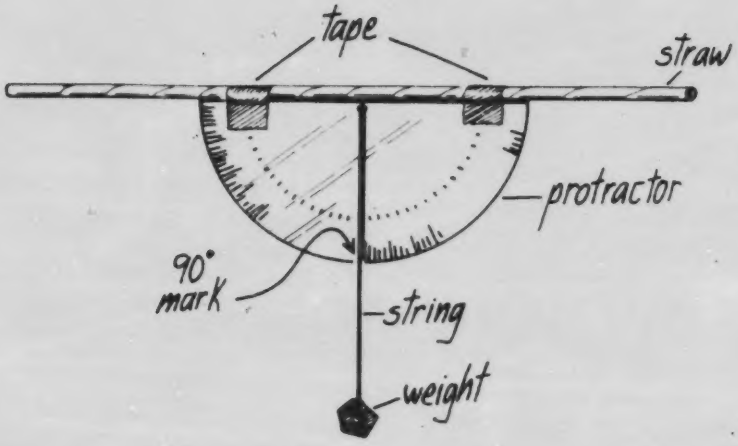
The astrolabe was used to measure the height of the sun and stars above the horizon. Used by the ancient Greeks and later by the Arabs, it was introduced to Europe about the 10th century.

Measuring Latitude By Polaris

Purpose: Construct and use a simple astrolabe (star sighter).
Observe celestial bodies and determine latitude.

Materials:

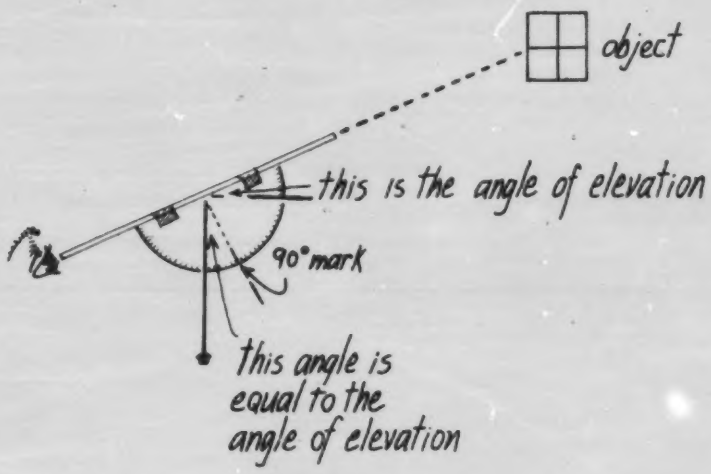
Protractor
Straw (plastic with fairly large diameter)
Tape
Line (thread about 10-15 cm in length)
Weight (a washer or nut will do fine)



Procedure:

1. Insert a string in the hole of the protractor, tie a knot in one end, and attach a weight to the other end.

2. Place the straw on the flat edge of the protractor and tape the straw in place. (See the illustration.)



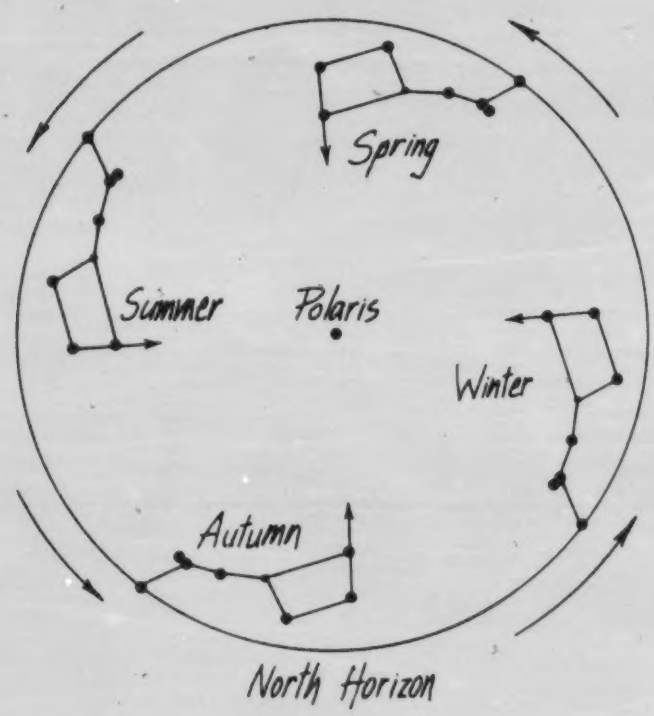
3. Use the straw as your sighter. Locate an object through the opening in your straw.

4. Allow the line to hang free while you are making your observation. When you are sure that you have located the object, place your finger on the thread to hold it in place. Lower the protractor (your astrolabe) and count the number of degrees from the 90° mark on the protractor to the thread's position. This number of degrees is equal to the number of degrees of elevation.

You need practice. Before you use your astrolabe (protractor) for celestial sighting, the class will select five objects around your school that you could practice on, to determine height of elevation. These could be objects on the horizon, chimneys, flagpole, the top of a building. Agree with your classmates which objects will be used and the place from which the sighting will be taken. All must follow the same procedure so that you can compare notes and check accuracy. Record these five observations on the Sky Observation Data Sheet in your answer book.

You are now ready to observe celestial objects.

1. The moon will be your first object. You will sight the *top* of the moon *three* different times during the evening. It will be necessary for the class to determine the time of sightings first, so everyone will be determining elevation at the same time. Record your information on the Sky Observation Data Chart in your answer book.



2. By using a sky chart, determine the planets that are in the evening sky at this time of year. Make three observations of each planet at intervals of 20 minutes. Again, determine the degree of elevation and record all information.

3. Locate Polaris (the North Star) on a star chart and in the northern sky. The pointers of the Big Dipper are helpful in locating Polaris. Refer to the drawing above.

4. Make three observations of Polaris at 20-minute intervals. Record the number of degrees of elevation.

After you have completed the above investigation, answer the following questions in your answer book.

1. You probably found that the elevation of the moon changed. Can you state why this was so? (2-12)
2. Why do you think the position of the planet changed? (2-13)
3. Your observations of Polaris should have brought different results. What makes Polaris different? (2-14)
4. Mariners have used Polaris for centuries to determine their latitude. How does your degree of elevation compare with the latitude of your area? (2-15)
5. Do mariners in the Southern Hemisphere use Polaris for navigation? Why or why not? (2-16)
6. How is the latitude of a point on earth determined?
   a. Traditionally, for centuries. (2-17)
   b. By recent sophisticated means? (2-18)
7. What is the latitude at the North Pole? (2-19)
8. What is the latitude at the South Pole? (2-20)
9. What is the latitude at the Equator? (2-21)

Independent Research: (Optional)

We have determined latitude but not longitude. An instrument was invented during the 18th century to locate positions east and west. This instrument is called a **chronometer**. Research how it helps a navigator determine his position east or west of Greenwich, England.

(D) Questions To Ponder

1. What causes hurricanes and how do they differ from typhoons?
2. Has a sea gull, albatross, or other sea bird ever flown across an ocean?
3. Why is the Cape Hatteras area known as the graveyard of ships?
4. How does an oceanographic ship anchor to take observations in the deep ocean?
5. Who is the most famous oceanographer?
6. Does oceanography include the study of lakes and streams?
7. Are there really sea monsters?
8. What is sonar?
9. How deep can submarines operate safely?
10. How do submarines navigate when submerged for weeks at a time?
11. What is the most important discovery made about the oceans?
12. What are the best materials to use for building a pier?
13. What is "ship route" forecasting?
14. How accurately can oceanographers predict ice formation, size, and movement?
15. What is the International Ice Patrol?
16. Why isn't there more interest and activity in recovery of sunken ships and treasures?
17. How are ships protected from corrosion and fouling?

(E) Self Evaluation

1. What is the difference between magnetic north and true north?
2. If the magnetic bearing is 90° and the variation is 11° W, what is the true bearing?
3. Deep blue color indicates what depth of water?
4. Why is Polaris, the North Star, used as the only star for sighting by navigators to determine latitude?
5. Explain how the astrolabe would confirm that the Equator is at 0° latitude.

Chapter III: Charting the "Hidden Lands"

Chapter Emphasis: The ocean bed is becoming increasingly important. We need up-to-date information on bottom topography for naval operations, search and salvage, undersea exploration, mining, oil drilling, fishing, and placing or anchoring cables, platforms, or instruments.

Objectives:

1. Given the time-lapse of a depth sound recorder, the student will compute the depth of the ocean at that point, using the average speed of sound in water of 4800 feet/second.

2. Given a graph of the ocean-bed profile, students will be able to compute distances of continental shelves, islands, mountain ranges, etc.

3. Given a series of depths at a specified distance from shore, students will be able to graph the contour of the ocean basin.

4. Given a profile of the ocean basin, students will be able to define the various formations.

5. Under prescribed conditions, students will be able to demonstrate a method of forming "nodules" from minerals dissolved in sea water.

Equipment:

Graph paper, 10 squares/inch
1000 ml Beakers
Copper sulfate crystals
Bunsen burners
Large metal tray and paper toweling
500 ml Graduate cylinder
Celsius thermometers

References:

1. *Oceanography in Action!* S.E. Seim, C.A. Grimstead, J.E. Gladden. Department of the Navy, Oceanographic Office, Washington, D.C. 1974.

2. NOTE: In *Oceanography* (1970, W. H. Freeman Co., San Francisco) the following articles show how sound has been used to study the sea floor, biology, and currents:

"The Continental Shelves," by K. O. Emery, p. 143.

"The Trenches of the Pacific," by Robert L. Fisher and Roger Revelle, p. 171.

"The Sea's Deep Scattering Layer," by Robert S. Dietz, p. 307.

"The Physical Resources of the Sea," by Edward J. Wenk, Jr., p. 347.

"The Circulation of the Abyss," by Henry Stemmel, p.72.

Films:

1. "Sounds in the Sea." Educational Film Division, Moody Institute of Science, 1200 E. Washington Blvd., Whittier, Calif. 90606. 14 min.
2. "Sounds in the Sea." U.S. Navy Assistant for Public Affairs of your Naval District (when writing refer to MN – 10409).
3. "Underwater Sound – Basic Principles." Graphic Arts Department, Woods Hole Oceanographic Institution, Woods Hole, MA. 02543. Color, 21 min.
4. "The Restless Sea." Free on loan from your local Bell Telephone Office. 60 min., color.

(A) Sounds in Water

Man has always been curious about the hidden world beneath his ship. Because of this vast unknown region, many myths and legends grow about the ocean deep. Magellan in the 16th century is given credit for the first "sounding" of the ocean by a navigator. He used a line 200 fathoms long. Today hundreds of vessels, aided by navigational satellites, are equipped with instruments that trace the profile of the ocean bottom.

Ships are equipped with **sonic depth recorders,** which send out a powerful sound impulse. Sound waves, which travel in water easily, are reflected back from the bottom to receiving equipment on the ship. The time it take for the sound impulse to return is automatically translated into a depth reading.

What needs to be known is the velocity (speed) of sound in sea water. Did you know that sound travels faster in water than it does in air? At sea level sound travels approximately 1100 feet/second in air. In salt water the velocity of sound is generally a little over 800 fathoms per second. (One fathom equals a depth of 6 feet). What is the speed of sound in feet per second? (3-1)

Equipment on shipboard automatically computes the depth and records the topography (highs and lows) of the ocean floor. Solve the following problems so that you will understand the process.

Suppose a sound impulse is sent from a ship toward the bottom of the ocean. The impulse strikes the ocean floor, reflects back, and the echo is picked up by the ship. If the time between the original sound and the returning echo is four seconds, how deep is the ocean?

Make your calculations as follows:

$$\frac{4 \text{ seconds}}{1} \times \frac{4800 \text{ feet}}{\text{second}} \times \frac{1}{2} = 9{,}600 \text{ feet}$$

Using the same method of calculation, determine the following depths. (3-2)

If the sound lapse time is 0.2 seconds, what is the depth?
If the sound lapse time is 1.5 seconds, what is the depth?
If the sound lapse time is 5.7 seconds, what is the depth?

(B) Profile of the Ocean Floor

The Atlantic Ocean from Cape May, New Jersey to Cape Roca, Portugal, along the parallel of 39° North

The table below gives figures based on U.S. Navy Hydrographic Office charts.

You are to draw the profile of the Atlantic Ocean floor at 39°N. latitude by plotting the points given in the table on the graph paper in your answer book. (3-3) Use a straightedge to connect the points.

Note: Distances from Cape May are in miles; recorded depth of the ocean is in fathoms. One fathom equals 6 feet.

Ocean Depths from Cape May, New Jersey to Cape Roca, Portugal

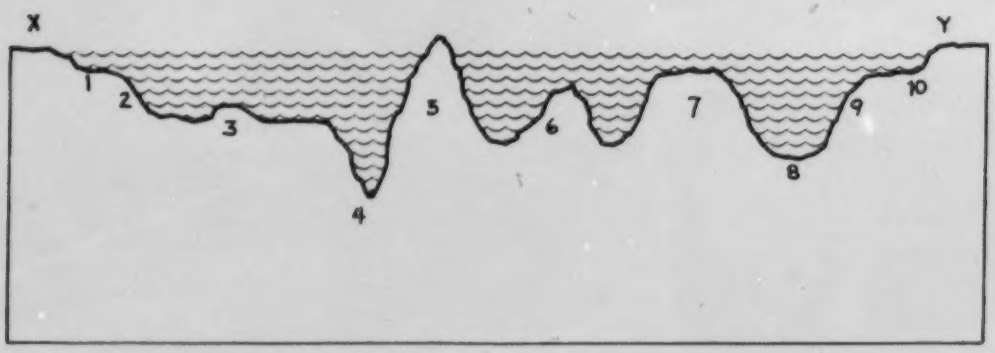
Distance	Depth	Distance	Depth
0 miles*	0 fathoms	2200 miles	1150 fathoms
100	100	2225**	750
125	1000	2325**	700
325	2000	2450**	550
475	2500	2475†	0
650	3000	2525	1000
900	2800	2700	2000
1125	2900	2800	2800
1300	3125	3150	2700
1425	2900	3300	2300
1475	2000	3400	1000
1600	1600	3425	500
1900	2500	3475	100
2000	2100	3500‡	0
2150	1800		

* Cape May
** North Atlantic Ridge
† Island in the Azores
‡ Cape Roca

You have just completed drawing the ocean floor across the Atlantic Ocean at 39°N. latitude. You have drawn several typical formations found in ocean basins throughout the world. You are to research definitions for some of the more typical ocean-basin formations. Write the definitions in your answer book (3-4) for the following words:

1. continental shelf
2. continental slope
3. continental rise
4. submarine canyon
5. mid-ocean ridge
6. island arc
7. ocean trench
8. guyot

If you have correctly defined the above formations, you will be able to identify the formations in the ocean profile below. Continents on either side of the ocean are represented by X and Y. In your answer book identify the numbered formations. (3-5)



Cross Section of an Ocean

Now refer to your graph from Cape May, New Jersey to Cape Roca, Portugal.

Label the continental shelves and slopes. How wide is the shelf at Cape May? (3-6) At Cape Roca? (3-7)

The horizontal scale used in the graph is 1 inch to 500 miles. The vertical scale is much larger – 1 inch for 6000 feet (a little more than a mile). What is the approximate vertical exaggeration of the graph compared with the horizontal scale? (3-8)

Because of the vertical exaggeration, slopes look much steeper than they really are.

(C) The Ocean Floor Tells a Story

One of the ways to learn about the ocean floor is to study the layers of **sediments** (matter that has settled to the bottom) that have been deposited throughout time. By studying sediments, geologists can get all sorts of information that increases our knowledge of the earth: changes in marine life, past climatic conditions, the presence of bottom currents, and much more.

Bottom samples are obtained by using grabs and dredges, and also corers which slice through the ocean floor and draw out vertical columns of sediments. Analysis of sedimentary layers is sometimes done by X-ray. Testing magnetism in rocks helps reveal any large-scale movement of rock masses that may have taken place in past ages. Underwater cameras and submersible vessels also reveal much about the bottom of the sea.

Sediment is made up of particles carried from the land through erosion and of the remains of living creatures of the sea. Organic sediments are skeletons of many plants and animals. When these organisms die, their skeletal remains become part of the bottom sediment.

Chemical deposits are the result of many chemical changes that take place in the sea. Some of these chemical reactions result in the formation of solid materials which settle to the bottom. An example is the presence of lumps or **nodules** over large areas in certain regions of the sea floor. Nations concerned about future supplies of minerals are interested in the exploration of the oceans. Nodules have been found to contain manganese, cobalt, nickel and copper.

The following experiment will help you to understand how minerals are deposited to form nodules. Do the experiment in groups of four to six.

(D) How Are Minerals in Solution Deposited To Form Nodules?

Equipment:

Two 1000 ml beakers
115 ml. Copper sulfate crystals
Water
Two bunsen burners
Small scoop
Large metal tray and paper toweling
One 500 ml graduate
Two Celsius thermometers

Method:

1. Using the graduate, place 500 ml of water in each beaker.
2. Heat the water to about 100°C.
3. Stand the two beakers on several layers of paper in the metal tray.
4. Stir copper sulfate crystals into both beakers, a spoonful at a time, until no more will dissolve.
5. Record the time. Drop one crystal of copper sulfate into one beaker only. Do not move either beaker but observe both at intervals of 10 minutes until the solutions cool to room temperature. Add another crystal to the beaker that has one extra crystal already in it.

Observations: (The following observations should be recorded in your answer book (3-8)

1. How much copper sulfate is dissolved by the water?
2. How do you know when no more will dissolve?
3. What happens in each beaker?
4. How long does it take?
5. What effect does the added crystal have on the solution?

Conclusions: (The following should be recorded in 3-9.)

1. How is this experiment similar to what happens in sea water?
2. Does adding the crystal change the way in which copper sulfate crystals grow?

(E) Questions To Ponder

1. Why is there a difference in the velocity of sound in air and water?
2. How are seamounts created?
3. What is the pressure at the deepest part of the ocean?
4. What is the Moho?
5. How thick is the sediment at the bottom of the ocean?
6. What is the greatest depth of the ocean and where is it?
7. How deep has man gone in the ocean?
8. What is the rate of sediment deposition on the sea floor?
9. What causes the hydrogen sulphide concentration at the bottom of the Black Sea?

(F) Self Evaluation

1. If a survey ship is 10 miles from shore and finds the time lapse of the depth sound recorder is 0.3 seconds, how deep is the ocean at this point? (Use the average figure of 4800 feet/second that sound travels in sea water.)

2. List three reasons why people investigage the ocean basin.

3. Identify the contour of the ocean basin which is nearest the shore line. This area is the center of much controversy because of its rich natural resources.

4. The Law of the Seas Conference attempts to define who legally owns the seas. List four natural resources that the sea and ocean bed hold.

Chapter IV: Charting the Water's Flow

Chapter Emphasis: The sea water is in constant motion. The motion or flow is predictable. Our objective is to help the student realize that constant and predictable forces cause these patterns. More insight into ocean currents can be gained by the students in Chapter VI, investigating properties of water.

Objectives:

1. Given the days of a month and heights of high and low tides during each day, the student will be able to graph the tides, showing a repeated, predictable pattern.
2. Given the phases of the moon for a month, the student will be able to predict the highest and lowest tides of the month.
3. Given a chart of the world's oceans, the student will be able to identify the major surface currents.
4. Given a major surface current, students will be able to tell its source, direction of flow, and temperature in terms of warm or cold.
5. Given a chart of the world's oceans, students will be able to identify patterns of current-flow in the northern and southern hemispheres which are predictable and constant.

Equipment:

Tide table for a one-month period
Graph paper, ¼ inch square
Globe or world map indicating surface ocean currents
Baby-food jars or soda bottles – small, thick-walled, with screw-on caps
3 x 5 Cards
Wax
Heat source

References:

1. *This Great and Wide Sea,* R.D. Coker. Harper and Row, New York, 1947.
2. *URI Marine Advisory Service,* Narragansett Bay Campus, Narragansett, R. I., 02882.
3. *The Global Sea,* Harris B. J. Stewart. D. Van Nostrand Company, Princeton, New Jersey, 1963.
4. *The Tide,* Harry Aaron Marmer. Appleton-Century-Crofts, New York, New York. 1926.
5. *Waves, Tides, and Currents,* Elizabeth Clemens. Alfred A. Knopf, New York, New York. 1967.
6. *Tide Chart* furnished by U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

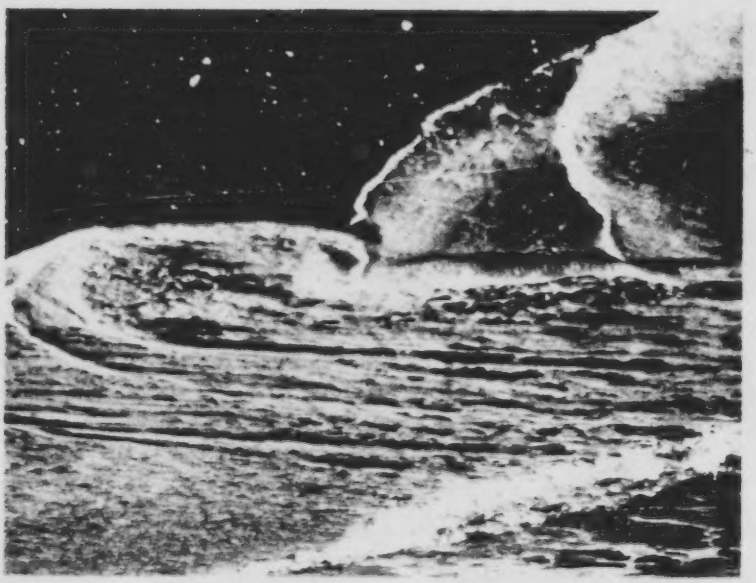
Films:

1. "Between the Tides" Contemporary Films, Inc., New York, N. Y. 10001. 22 minutes, color.
2. "The Grunion Story." Excellent film with diagrams of biological clocks and their relationship to spring tides. Original source unknown; available from Massachusetts Cooperative Film Rentals, State Department of Education, Boston.

Nearly everyone has heard about the rise and fall of the tide every day, and nearly everyone knows that the tides are caused by the gravitational pull of the sun and moon. Information about the tides has always been of great importance to navigators, especially in guiding ships in and out of harbors and operating in shallow waters near shore and around islands. In time of war, a knowledge of the tides of a particular area is essential before an operation can be planned where boats, men, and materials have to be landed along a shore.

Recently the tides have been investigated as a possible source of energy to generate electricity.

In order to study the tides, we must take observations of the *time* of rise and fall and the *amount* of rise and fall of the tide each day over a long period. After a number of recordings are collected for various places around the world, certain characteristics of the tide can be discovered and predictions made for the future.



Have you ever laid your shoes or towel at the water's edge
and then . . . the *tide came in!*

The tides along the east coast of the United States are classified as **diurnal**: two high waters and two low waters each day, with little or no difference between consecutive high- or low-water heights. Not all tides around the world follow this pattern.

(A) Making a Monthly Tide Graph

Purpose: To discover whether there is any relationship between tide patterns and the moon's phases.

Materials:

A tide table
Graph paper, ¼-inch squares if available

Procedure:

You will make a graph of tides (preferably in your local area) for a one-month period and record monthly lunar cycles on the chart.

The vertical axis of your chart will be the **height of the tide**. Each square will stand for 1 foot. The horizontal axis will be the **time**. Each square will stand for 6 hours. Four squares will be one 24-hour day.

In order to graph 30 days, it will be necessary to tape three sheets of graph paper together the long way.

It is important that the times of the high and low tides be plotted accurately.

Label monthly lunar cycles on the chart.

Observations:

1. During what day is the *range* largest? (4–1)
2. During what day is the tide range the smallest? (4–2)
3. Under what phase(s) of the moon do you find the largest tide range? (4–3)
4. Under what phase(s) of the moon do you find the smallest tide range? (4–4)

SANDY HOOK, N.J., 1975
TIMES AND HEIGHTS OF HIGH AND LOW WATERS

JANUARY						FEBRUARY						MARCH					
DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.	DAY	TIME	HT.
	M.M.	FT.		M.M.	FT.		M.M.	FT.		M.M.	FT.		M.M.	FT.		M.M.	FT.
1	0351	-0.9	16	0400	0.0	1	0521	-0.7	16	0440	0.1	1	0408	-1.1	16	0346	-0.1
W	1000	5.3	TH	1002	4.3	SA	1127	4.6	SU	1047	3.9	SA	1011	4.9	SU	0941	4.2
	1629	-1.2		1623	-0.3		1745	-0.8		1647	0.0		1628	-1.0		1547	0.0
	2238	4.7		2226	3.9					2306	4.2		2242	5.3		2154	4.6
2	0444	-0.7	17	0434	0.2	2	0004	4.9	17	0519	0.3	2	0458	-0.8	17	0419	0.0
TH	1053	5.0	F	1040	4.1	SU	0618	-0.4	M	1127	3.7	SU	1104	4.5	M	1019	4.0
	1719	-1.0		1656	-0.1		1223	4.2		1724	0.1		1716	-0.6		1617	0.1
	2335	4.7		2304	3.9		1841	-0.4		2349	4.2		2335	5.0		2234	4.6
3	0541	-0.5	18	0509	0.3	3	0100	4.7	18	0615	0.4	3	0553	-0.4	18	0459	0.2
F	1149	4.7	SA	1119	3.9	M	0723	-0.1	TU	1215	3.6	M	1158	4.1	TU	1104	3.8
	1814	-0.7		1730	0.0		1321	3.8		1815	0.3		1810	-0.1		1655	0.2
				2346	3.9		1944	-0.2								2319	4.5
4	0031	4.7	19	0554	0.5	4	0159	4.5	19	0043	4.2	4	0030	4.7	19	0546	0.4
SA	0644	-0.3	SU	1203	3.7	TU	0830	0.0	W	0725	0.5	TU	0655	0.0	W	1156	3.7
	1247	4.3		1812	0.1		1421	3.6		1313	3.5		1253	3.8		1745	0.4
	1913	-0.5					2045	0.0		1928	0.3		1912	0.2			
5	0128	4.6	20	0031	3.9	5	0300	4.3	20	0144	4.2	5	0125	4.4	20	0015	4.4
SU	0752	-0.1	M	0659	0.6	W	0932	0.0	TH	0839	0.4	W	0758	0.2	TH	0657	0.4
	1346	4.0		1251	3.5		1527	3.4		1425	3.5		1353	3.5		1255	3.7
	2015	-0.4		1908	0.2		2145	0.0		2043	0.2		2016	0.4		1900	0.5
6	0229	4.6	21	0123	4.0	6	0403	4.4	21	0257	4.4	6	0226	4.2	21	0119	4.4
M	0856	-0.1	TU	0808	0.5	TH	1027	0.0	F	0942	0.1	TH	0903	0.3	F	0811	0.3
	1450	3.8		1349	3.4		1633	3.5		1537	3.7		1458	3.5		1405	3.8
	2114	-0.3		2013	0.2		2241	0.0		2148	-0.1		2119	0.4		2023	0.4
7	0329	4.6	22	0223	4.1	7	0500	4.5	22	0407	4.6	7	0329	4.1	22	0228	4.5
TU	0956	-0.2	W	0913	0.3	F	1119	-0.1	SA	1041	-0.3	F	0958	0.2	SA	0916	0.1
	1553	3.7		1455	3.4		1728	3.7		1646	4.1		1603	3.5		1515	4.0
	2207	-0.3		2116	0.0		2331	-0.1		2250	-0.4		2214	0.3		2132	0.1
8	0430	4.7	23	0331	4.3	8	0550	4.6	23	0510	5.0	8	0430	4.2	23	0342	4.6
W	1051	-0.4	TH	1010	0.0	SA	1205	-0.3	SU	1136	-0.7	SA	1048	0.1	SU	1015	-0.3
	1655	3.8		1606	3.6		1813	3.9		1744	4.6		1659	3.8		1623	4.5
	2300	-0.2		2213	-0.2					2349	-0.8		2307	0.2		2233	-0.3
9	0524	4.8	24	0435	4.7	9	0019	-0.2	24	0605	5.4	9	0521	4.4	24	0447	4.9
TH	1144	-0.4	F	1107	-0.3	SU	0832	4.7	M	1229	-1.0	SU	1134	-0.1	M	1110	-0.6
	1748	3.9		1709	3.9		1251	-0.4		1836	5.1		1747	4.0		1723	5.0
	2351	-0.3		2310	-0.5		1853	4.1					2354	0.0		2332	-0.7
10	0611	4.9	25	0532	5.1	10	0104	-0.3	25	0045	-1.1	10	0605	4.5	25	0545	5.2
F	1233	-0.5	SA	1200	-0.7	M	0712	4.8	TU	0656	5.6	M	1219	-0.2	TU	1203	-0.9
	1835	3.9		1804	4.3		1313	-0.5		1321	-1.3		1827	4.3		1815	5.5
							1932	4.2		1925	5.4						
11	0039	-0.4	26	0005	-0.8	11	0146	-0.3	26	0139	-1.3	11	0040	-0.1	26	0028	-1.0
SA	0653	5.0	SU	0624	5.4	TU	0747	4.7	W	0744	5.7	TU	0645	4.7	W	0637	5.4
	1317	-0.5		1255	-1.0		1410	-0.5		1409	-1.5		1259	-0.3		1254	-1.1
	1915	4.0		1856	4.7		2007	4.3		2012	5.6		1903	4.5		1904	5.8
12	0125	-0.4	27	0101	-1.1	12	0224	-0.3	27	0230	-1.4	12	0122	-0.2	27	0122	-1.2
SU	0733	4.9	M	0714	5.6	W	0823	4.7	TH	0832	5.6	W	0722	4.7	TH	0725	5.5
	1359	-0.6		1345	-1.3		1446	-0.5		1456	-1.5		1338	-0.4		1343	-1.2
	1954	4.0		1944	5.0		2041	4.3		2101	5.7		1938	4.6		1950	6.0
13	0207	-0.3	28	0155	-1.3	13	0301	-0.3	28	0320	-1.4	13	0201	-0.3	28	0212	-1.3
M	0812	4.8	TU	0801	5.7	TH	0858	4.5	F	0923	5.3	TH	0757	4.7	F	0812	5.4
	1439	-0.6		1433	-1.5		1520	-0.4		1541	-1.3		1414	-0.4		1431	-1.2
	2033	4.0		2033	5.1		2115	4.3		2152	5.5		2015	4.7		2037	6.0
14	0247	-0.3	29	0246	-1.3	14	0334	-0.2				14	0238	-0.3	29	0301	-1.2
TU	0846	4.7	W	0851	5.6	F	0934	4.3				F	0832	4.5	SA	0900	5.2
	1515	-0.5		1520	-1.5		1549	-0.3					1448	-0.3		1517	-1.0
	2110	4.0		2123	5.2		2149	4.2					2045	4.7		2126	5.8
15	0324	-0.1	30	0336	-1.3	15	0408	0.0				15	0313	-0.2	30	0349	-1.0
W	0926	4.5	TH	0942	5.3	SA	1008	4.1				SA	0907	4.4	SU	0950	4.8
	1549	-0.4		1605	-1.4		1618	-0.2					1518	-0.2		1603	-0.6
	2147	3.9		2216	5.2		2224	4.2					2118	4.7		2216	5.5
			31	0428	-1.1										31	0437	-0.6
			F	1034	5.0										M	1040	4.5
				1653	-1.1											1648	-0.2
				2309	5.0											2305	5.1

TIME MERIDIAN 75° W. 0000 IS MIDNIGHT; 1200 IS NOON.
HEIGHTS ARE RECKONED FROM THE DATUM OF SOUNDINGS ON CHARTS OF THE LOCALITY, WHICH IS MEAN LOW WATER.

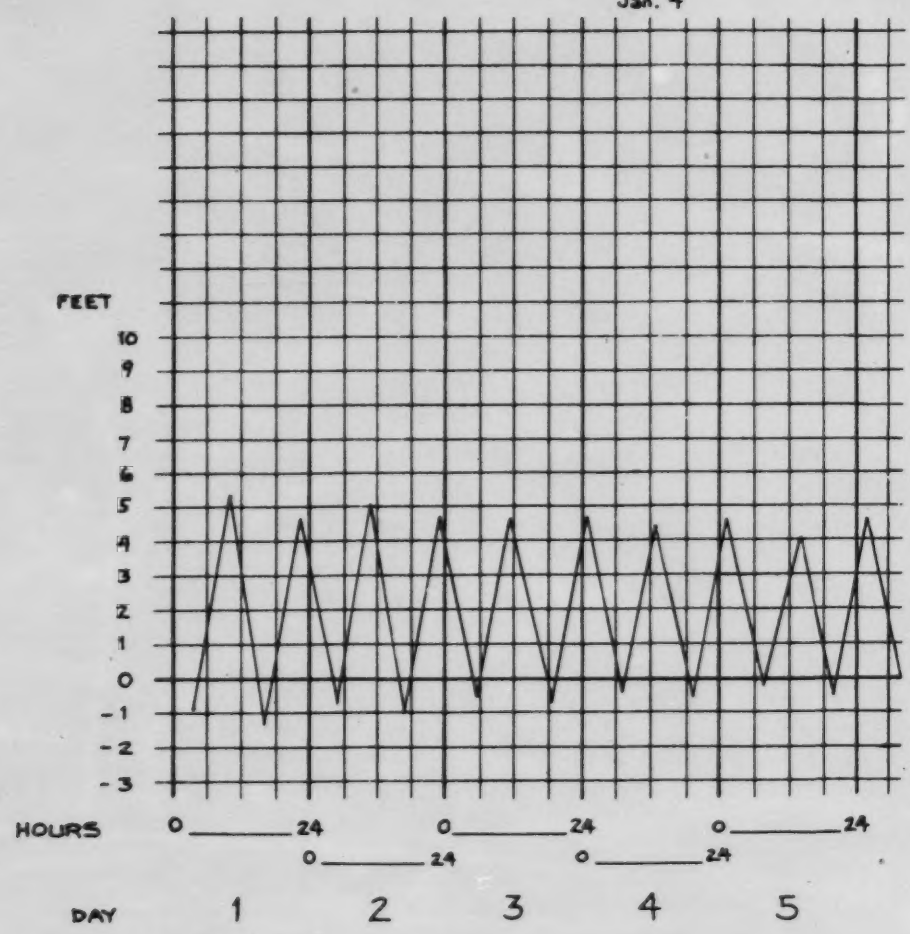
CHART FURNISHED BY U.S. DEPARTMENT OF COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION.

MOON PHASES IN JANUARY 1975: LAST QUARTER, JANUARY 4; NEW MOON, JANUARY 12; FIRST QUARTER, JANUARY 20; FULL MOON, JANUARY 27.

Sample of a Tide Graph of the Times and Heights
of Low and High Waters at Sandy Hook, N.J.
January, 1975

(Draw in the major phases of the moon.)

Last quarter
Jan. 4



When the moon and sun are in a straight line with the earth (every 2 weeks – at the new or full moon), they pull together, and the tides are greatest. These are **spring** tides that occur when the water "springs" up. (The term "spring" has nothing to do with the season of the year).

When the moon, sun, and earth form a right angle (first and last quarters), the pulls oppose each other, and the water is "nipped," or lowered; these are **neap** tides.

Currents are another type of "flow" in the oceans. Currents, the so-called "rivers in the sea," are important to marine scientists, naval forces, fishermen, engineers, sailors, coastal-zone planners, and many others. Ocean currents greatly affect the climate of surrounding lands. Currents affect the chemical properties of water masses; they also help to distribute the countless numbers of plankton (drifting or weakly swimming organisms) that inhabit the ocean. Ships may lose time trying to navigate against a strong current. Coastal cities that dispose of sewage in the sea must know the strength and direction of currents that may carry the wastes; this knowledge also is needed by those who want to dump wastes at sea. Erosion and creation of beaches are influenced by near-shore currents. Placement of instruments and equipment in the ocean should take into account the currents of the region.

(B) Where Are the Major Ocean Currents?

The following investigation will help answer that question.

Objective:

To study the direction and movement of ocean currents.

Materials:

A globe or map of the world which indicates the direction and temperature of the currents.

Procedure:

Draw and label the following currents on the map in your answer book. Show the cold currents by a solid line and the warm currents by a dotted line.

Be sure you know which line on your map represents the equator, 0° latitude. This will serve as a landmark for the currents, especially the equatorial currents. Be sure to note accurately the direction of the equatorial currents. Label all the continents, Greenland, Iceland, and Madagascar.

North Equatorial Current
South Equatorial Current
Equatorial Counter Current
Gulf Stream
Labrador Current
North Atlantic Drift
Sargasso Sea
Japan Current
Peru Current
Benguela Current (west coast of Africa)
California Current
Mozambique Current (between Madagascar and southeast coast of Africa)
Canary Current (Canary Islands)
Australian Current (east coast of Australia)
Antartic Current

Observations:

1. What is the direction of the currents in the northern hemisphere, clockwise or counterclockwise? (4–5)
2. What is the direction of the currents in the southern hemisphere, clockwise or counterclockwise? (4–6)
3. Although London, England is farther north than Albany, New York, its winters are milder. How do you account for this? (4–7)
4. The fogs off Newfoundland are famous. What causes them? (4–8)
5. The Sargasso Sea is a sea within a sea, encircled by several currents. Do you think the Sargasso Sea is generally calm or rough? (4–9)
6. The "unsinkable" Titanic ocean liner was sunk in 1912 by collision with an iceberg in the North Atlantic. Which current is responsible for the icebergs in the North Atlantic? (4–10)

An Optional Investigation: The **Coriolis effect** is responsible for the pattern of surface ocean currents. Investigate the phenomenon of the Coriolis force. How does it affect the northern hemisphere surface ocean currents? the southern hemisphere currents?

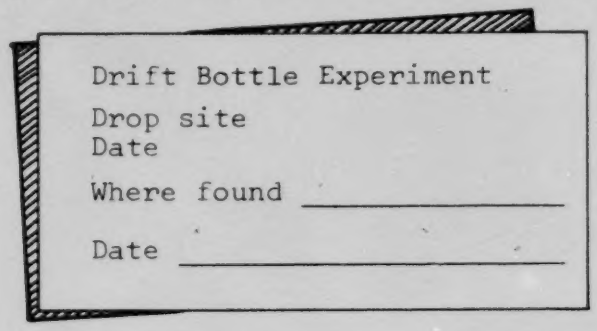
(C) Current Bottles

Materials:

Baby-food jars or
Soda bottles, small, thick-walled with screw-on caps
3 x 5 Cards
Wax

Procedure:

First the cards must be marked. Be sure to use a soft pencil. Ink will rapidly fade in sunlight and these bottles are frequently exposed to weeks of direct light. On one side of the card write your name and school address. See below for the opposite side:



After the cards are marked and placed in the bottles, put the caps on as tightly as possible. The cap should then be dipped in hot wax and allowed to cool.

CAUTION: Hot wax is flammable and can also cause severe burns. The wax should be handled with extreme care.

After the wax has cooled, second, third, and fourth dippings are suggested. Be sure to make them brief, or else you will simply melt off the wax from the previous time. Allow the wax to cool between each dipping.

If the wax you use is too brittle for a good waterproof seal, add a small amount of petroleum jelly to soften it.

After the bottles are sealed (you can spot-check with a bucket of water), they are ready to be used.

When selecting a spot to throw your bottles, a few things should be kept in mind.

(1) Try to select a place where there are definite currents, preferably headed offshore.

(2) Try to avoid throwing the bottles during a strong incoming tide.

(3) Bottles thrown off during the outgoing tide, particularly near a river, can often be carried a long way offshore.

(4) If you have access to a boat, your problems are greatly simplified because you can select the best drop sites.

(5) Throw off at least 10 bottles from any given spot.

You'll find that most people are very interested in knowing what you are doing. Some may request more information about your experiment of studying the currents. Your local newspaper may also be interested. Contact them when you get your first card back!

(D) Questions To Ponder

1. How long and wide is the Gulf Stream?
2. Are there strong currents at depths beneath the ocean surface that might compare to the jet stream in the upper levels of the atmosphere?
3. What causes hurricanes and how do they differ from typhoons?
4. Why do tide ranges in the same geographical areas of the world differ so greatly?
5. What causes tidal waves?
6. Can tidal waves be forecast?
7. What are turbidity currents?
8. How high is the highest wave?
9. How much power (energy) is in a wave?
10. Are the rise and fall of tides used to develop power?
11. What is a storm surge?
12. What makes a very slight swell (wave) become much higher when it breaks on the shore as surf?
13. Where do waves come from?

(E) Self Evaluation

1. Describe the pattern of diurnal tides.

2. Under what phase(s) of the moon will the east coast of the U.S. experience the highest high tides?

3. Under what phase(s) of the moon will the east coast of the U.S. experience the lowest high tides?

4. a. What surface ocean current affects the climate of the east coast?
   b. What surface ocean current affects the climate of the west coast?
   c. What surface ocean current affects the climate of the British Isles?

5. Name two currents in the Northern Hemisphere that have their source in the North Equatorial Current.

6. Name two currents in the Southern Hemisphere that have their source in the Antarctic Current.

7. What is the direction of the flow pattern of the surface currents in the Northern Hemisphere?

8. What is the direction of the flow pattern of the surface currents in the Southern Hemisphere?

Chapter V: Marine Careers

Chapter Emphasis: Students investigate marine-related careers.

Objectives:

1. By means of student investigation, a Marine Career Resource Center will be formed.

2. The student is required to decide which career s/he will investigate.

3. The student will write a letter of inquiry.

4. After receiving a reply, the student will summarize his/her information and contribute it to the Marine Career Resource Center.

or

having received insufficient information, will write to another source.

References:

1. *Preparing for a Career or Profession in Marine Science*, Robert Bailey, Virginia Institute of Marine Science, Gloucester Point, Virginia, Educational Series No. 14.

2. *Employment Outlook for Earth Scientists: Oceanographers.* Catalog No. L 2, 3: 1550-29. U.S. Government Printing Office, Division of Public Documents, Washington, D.C. 20402.

3. *Opportunities in Oceanography.* Smithsonian Press. Smithsonian Institution, Washington, D. C. 20560.

4. *Oceanography Information Sources.* Printing and Publishing Office, National Academy of Science, 2101 Constitution Avenue, Washington, D.C. 20418. 1966.

5. *Your Future in Oceanography*, Norman H. Gaber. Richards Rosen Press, Inc., 29 East 21st Street, New York, N.Y. 10010. 1967.

6. *Opportunities in Oceanographic Careers*, Odom Fanning. Universal Publishing and Distributing Corporation. New York, N.Y. 10017. 1969.

7. *Your Career in Oceanography*, Walde T. Boyd. Julian Messner, New York, N.Y. 1968.

8. *Sea Frontiers* (magazine) and *Sea Secrets* (bulletin). The International Oceanographic Foundation, 10 Rickenbacker Causeway, Virginia Key, Miami, Florida 33149. Sent to members. Membership $7.50 annually as of 1977.

9. *The Oceans and You: Oceanography Information Kit.* American Society for Oceanography, 1730 M Street N.W. Suite 412, Washington, D.C. 20036.

10. *A Reader's Guide to Oceanography* (a high - school level introduction to oceanography); *Questions and Answers;* and *The Woods Hole Oceanographic Institution – Research and Education.* All available without charge from the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543.

11. *Oceanographical Engineering*, Robert L. Wiegel. Prentice-Hall, Englewood Cliffs, N. J.

12. *Oceanography in Action!* S.E. Seim. The U.S. Naval Oceanographic Office.

13. *Seven Miles Down*, Jacques Piccard and Robert S. Dietz. Putnam, New York.

14. *Underwater Work*, John E. Cayford. Cornell Maritime Press, Cambridge, Md.

Films:

1. Motion Picture Service, Department of Commerce—NOAA, 12231 Wilkins Avenue, Rockville, Maryland 20852. (301) 496-8411.
   Several career-oriented films are available if ordered three months in advance. Order their catalog.

2. "The Marine Biologist," Encyclopedia Britannica Films, Inc., 425 North Michigan Avenue, Chicago.

3. "Scientist in the Sea," U.S. Navy, Assistant for Public Affairs for your Naval District. (When writing refer to MN—10320).

To maintain a focus on the progess of responses to student letters, the following procedure is suggested.

a. Place a fairly large map of the U.S. on the bulletin board.

b. By markers, locate places to which students are writing.

c. As students address the envelopes, they should also put the name and address of their resource on a small card, held by you.

d. When an answer is received, these cards should be placed around the perimeter of the map, attached to the markers of the proper city by string, yarn, or thread.

e. If any brochures, charts, etc. are received, they may be added to the sides of the display.

Incidentally, this improves the student's knowledge of United States geography!

Chapter V: Marine Careers

You have spent some time learning a little bit about 71 percent of the earth's surface – approximately 140 million square miles.

Today the oceans have a new meaning to mankind. Many scientists believe that the seas hold the only really hopeful solution to the problems of food, water, and fuel; diminishing mineral resources; and possibly safe radioactive-waste disposal. These problems have become greatly magnified as the world's population threatens to increase beyond the ability of the land to support its people.

A statement repeated: *Our planet Earth needs well-trained men and women to investigate, preserve, and use the resources of the sea wisely for the benefit of all people everywhere.*

While we are studying the oceans, you are to choose a career, investigate it, write a description of the career and contribute it and any related information to the **Marine Career Resource Center.**

From the following list of marine careers choose one which interests you.

Because of the great variety of marine-related jobs available, education requirements differ greatly. You must spend at least 8 years studying after completing high school to become a **marine biologist, geophysicist, geologist, meteorologist, hydrographer, hydrologist,** or a social scientist such as a **marine-resource economist, marine lawyer, coastal-zone planner,** or a **marine architect** or **marine engineer.** Those who care for animals might also have the same educational requirements, such as a **veterinarian, marine naturalist,** or one in charge of a **marine aquarium.** Those who would like to operate their own marine business, such as a **marina,** a **ship chandler** (supplies and provisions store), or a **fish processing plant,** will need training in business management. The scientific **photographer, technical illustrator,** or **cartographer** will need communications skills.

Technicians, who are needed to operate and maintain equipment, may require 2 to 4 years of education beyond high school. Technicians may be involved in such activities as reading sonar "pings," recording the sounds and distribution of whales in their natural environment, determining the noise levels of traffic in major oceanic ship lanes, using satellite remote-sensing instrumentation, placing instruments and equipment in the ocean, using chemical techniques to study water pollution, making sketches and drawings, to name a few. The technician supports scientists and engineers either directly or indirectly.

Mining chemicals, oil, and gas from the oceans offers many careers in **marine engineering and technology. Deep-sea divers, scuba divers, seismograph readers,** and **installers** are a few examples.

Increasingly, **pilots** are used in support systems and are employed by marine organizations.

Merchant marine sailors and **officers, navy sailors** and **officers,** as well as **coastguard sailors** and **officers** are some of the possible jobs at sea.

For some jobs at sea such as **sailmaking, fishing,** and being a **boat captain,** education is generally obtained through apprenticeship and/or experience.

The sea has continually inspired **artists, poets, composers,** and writers.

Fishing offers a variety of careers, such as **clam-dredge operator, spear fisher, sponge gatherer, kelp cutter, crew members on commercial deep-sea fishing boat,** and **fish processor.**

Opportunities are increasing in the relatively new field of **aquaculture.** You might be interested in the careers of **fishing bacteriologist, fish culturist, fish farmer, kelp farmer, shellfish grower, mollusk farmer,** or a **pearl culturer.**

If you have increased the list of careers during your study and class discussion, keep a record of them in your answer book.

You will find in the appendix, lists of colleges and universities which have courses in oceanography, plus organizations, schools, government agencies, businesses, and industries which can help you gather information on marine careers. Your teacher will have additional resources. Do not overlook the yellow pages in the telephone book.

You should be ready to write a letter (or letters), obtain interviews, seek advice from professionals in your area, visit a work site, etc.

When you are writing a business letter, remember to observe certain rules. If you write a good letter, you have a better chance of receiving a prompt and courteous response.

(A) Suggestions for a Business Letter

1. Give an accurate and complete return address in the upper right corner. Leave a margin.

2. The date is written under your return address.

3. State the business address accurately and completely.

4. Skipping a space under the business address, write a courteous greeting, such as "Dear Sir or Madam:".

5. Make your request for career information specific and as brief as possible.

   You might write that you are studying oceanography and have become interested in scuba diving (as an example).

   Ask for information on scuba diving and particularly for information about career opportunities in scuba diving.

   You might ask what education and/or training is required for a career in scuba diving.

   Are there any special requirements?

   What is the nature of the work?

   Is the field of employment expanding?

   What is the salary range?

6. Close by writing "Yours truly," or "Sincerely yours,".

A rough copy and a corrected copy of each letter sent is to be written in your answer book. After you have received information from one or many sources, had an interview, visited a work site, etc., then you are to fill out the card to be on file in the **Marine Career Resource Center**. You will get the form from your teacher.

You will find that many people care about you and your future career.

Use this experience to research other careers that may interest you.

(B) Supporting Occupations

Only a small number of those who earn their living from the sea actually work on it. Most work at the edge of the sea, conducting all the business that depends on the sea or that is necessary to support seaborne activities. And millions of people come to the edge of the sea for recreation. They in turn create more jobs.

In your answer book make the silhouettes of a sailing yacht and a fishing boat. Then make a list of all the people whose jobs relate to both of these types of vessels. Some of these people support each other as well as the vessel and its owners. Try to think of all the interrelationships. Have a contest with your classmates to see who can come up with the most complete list. The following is an example to get you started.

OFFICE STAFF MEMBER

STEVEDORE

EXPORTER-IMPORTER

SUPPLY and MAINTENANCE PERSON

MARINE ELECTRONICS TECHNICIAN

METEOROLOGIST

MARINE TECHNICIAN

MARITIME LAWYER

SHIP'S CHANDLER

INSURANCE UNDERWRITER

MARINE RADIO-TELEPHONE OPERATOR

OCEANOGRAPHER

CUSTOMS AGENT

SHIPBUILDER

SHIP'S CAPTAIN

COAST GUARD MEMBER

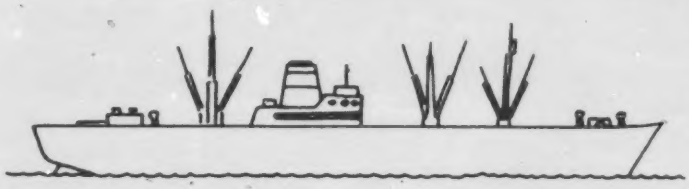
ENGINEER

CARTOGRAPHER

CREW

BROKER

OWNER



FREIGHTER WITH ITS SUPPORTING OCCUPATIONS

(C) Marine Career Crossword Puzzle

Now that your list of marine-related occupations has grown, use these occupations to create a marine-career crossword puzzle. Use a second sheet of graph paper for your final form. Be sure that the numbers in your definitions agree with the numbers in your puzzle.

Chapter VI: What *Is* the Ocean's Greatest Natural Resource?

Chapter Emphasis: Ample pure water is of prime importance to people's well-being and indeed survival. Fresh water is consumed in huge quantities. Sea water's properties are studied.

Objectives:

1. Students will be able to list significant uses of water.
2. By experiment, students will be able to determine the effect of temperature and salinity on the density of water.
3. By experiment students will be able to determine the property of water that it resists temperature change.
4. By experiment students will determine that waters of different densities do not mix, but create distinct layers.
5. By experiment students will determine that atmospheric conditions produce different rates of evaporation, which in turn produce different levels of salinity in the oceans.

Equipment:

Samples of fresh water
Samples of sea water
Samples of salt water
Watch glasses or glass slides
Microscope
12-Volt battery
Ammeter
Beakers
Pin electrodes
Thermometers, Celsius
Wire loop or pipe cleaner
Rectangular glass tank
Methylene blue solution or other coloring fluid
Corks
Graduated cylinders, 100 ml, 500 ml
Stirring rod
Small test tubes
Test-tube holders
Wooden-handled dissecting probes
Corks suitable for closing off the test tubes
Sand or lead shot
Burner
Heavy paper
Large glass jar or beaker
Long-stemmed funnel
Ice

The teacher or aide will have to make up various salt solutions of different densities for use in the experiments.

Demonstration – Water of Different Densities

Since one of the emphases of this chapter is on the density of water, why not start this chapter with a demonstration, giving no explanation. Students will write their observations and conclusions in their answer books. At the end of the chapter they may wish to revise their statements.

Materials:

Large glass beaker or jar
Smaller beaker (for mixing salt solution)
Salt
Food coloring (yellow and blue)
Long-stemmed funnel

Procedure:

1. Make a saturated salt solution (about 30 to 35 grams of NaCl per 100 ml water) and add a few drops of blue food coloring.

2. Fill large beaker or jar half full of tap water (about room temperature) and add several drops of yellow food coloring.

3. Place a long-stemmed funnel in the yellow solution (tip at the bottom of the jar).

4. Slowly pour the blue salt solution into the funnel. Two layers will form. Any mixing of the solutions will appear as a thin green band between the two layers. If the jar is left undisturbed, the layers remain quite distinct for at least three weeks.

The students will record their observations of the experiment and their conclusions in their answer books. (6–1)

References:

1. *101 Things You May Not Know About Water.* Mountain Valley Water, Hot Springs, Arkansas. Free to classroom teachers. Send request to Mountain Valley Water, 1440 Broadway, N.Y., N.Y. 10018.

2. *Water: The Mirror of Science,* Kenneth S. Davis and John Arthur Day. Doubleday and Company, New York, New York. 1961.

3. *1001 Questions Answered About the Oceans and Oceanography,* Robert W. Taber and Harold W. Dubach. Dodd, Mead and Company, New York, N. Y. 1972.

4. *Oceanography – Readings From The Scientific American,* J. Robert Moore. W.H. Freeman and Company, San Francisco, Cal. 1971.

5. *Basic Earth Science,* MacCracken, Decker, Read, and Yarian. The L.W. Singer Company, Syracuse, N.Y. 1964.

Investigations with the hydrometer were devised by J. Crowley and J. Stouffer, Highham High School, and are adapted from *This Great and Wide Sea,* by R. D. Coker. Harper and Row, New York, N.Y.

(A) Test Yourself: Water Uses

"Water is an overwhelming part of our existence. Without it, we cannot live."

How much do you already know about water? Test yourself by choosing the best answer to the following twelve questions.* Record the letters in your answer book. (6–2)

1. Which is true of water?
   a. Water appears as a gas.
   b. Water appears as a liquid.
   c. Water responds slowly to heat.
   d. Liquid water expands when frozen.
   e. All of these

2. Where is most of the world's fresh water?
   a. Frozen in the polar ice caps
   b. In the fresh-water lakes
   c. In the rivers and streams
   d. In the atmosphere as water vapor

3. Where is most of the earth's water?
   a. In the oceans
   b. In the glaciers
   c. In lakes, rivers, streams, and ponds
   d. As vapor in the air

4. What water use requires the largest supply daily?
   a. Washing
   b. Drinking
   c. Irrigation
   d. Cooking

5. How much water does the average American use daily?
   a. 5 gallons
   b. 50 gallons
   c. 100 gallons
   d. 150 gallons

6. How much *hot* water is used daily in the American home?
   a. About 20 gallons
   b. About 50 gallons
   c. About 120 gallons
   d. About 200 gallons

7. Which chemical is the principal water pollutant?
   a. Nitrogen
   b. Copper
   c. Zinc
   d. Carbon

8. What is the best cleanser of polluted waters?
   a. Baking soda
   b. Ordinary water reeds
   c. Scavengers
   d. Oxygen

* Taken from a booklet "101 Things You May Not Know About Water," published by Mountain Valley Water, Hot Springs, Arkansas.

9. Which is the worst offender in water pollution?
   a. Industry
   b. Municipalities
   c. Farmland treated with chemicals
   d. Sewage

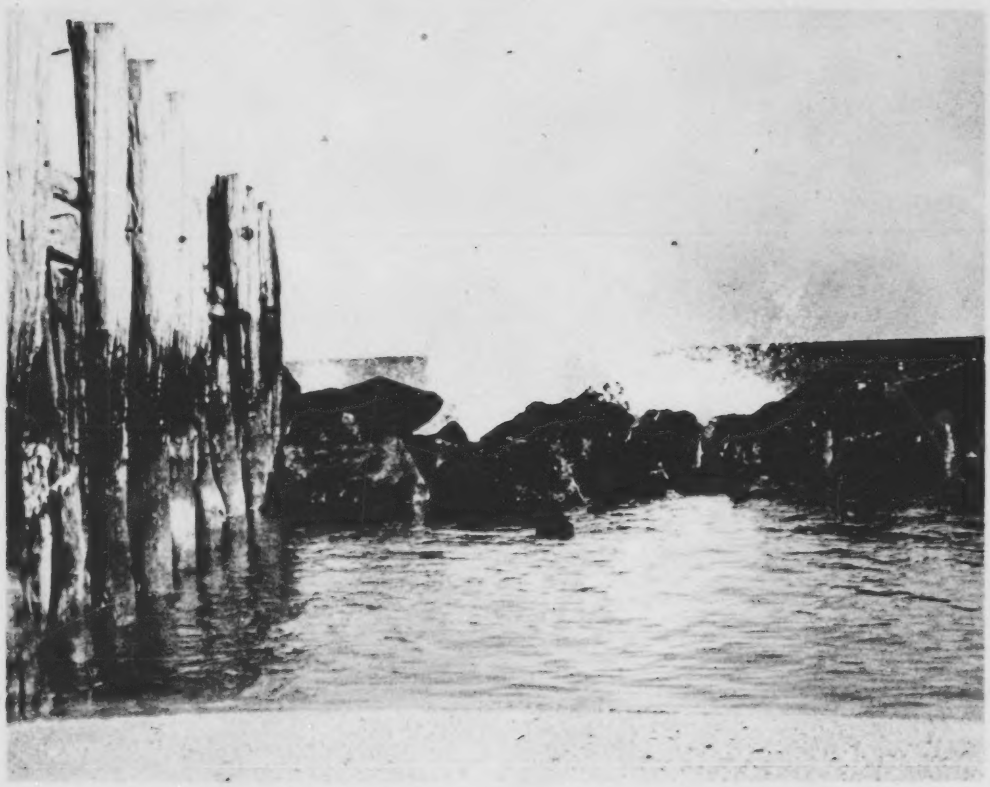
10. How long can a person live without water?
   a. Three days
   b. Five days
   c. 7–10 days
   d. Up to two weeks

11. What is the daily rainfall in the United States?
   a. About 100 million gallons
   b. About 500 million gallons
   c. About 1 billion gallons
   d. About 4300 billion gallons

12. What industry in this country uses the most water?
   a. Pulp and paper industry
   b. Steel industry
   c. Food-processing
   d. Health and medicine industry

Check your answers on page 67. Record the number of correct answers. (6–3).

Questions 2 and 3 will be discussed more fully in the next section.

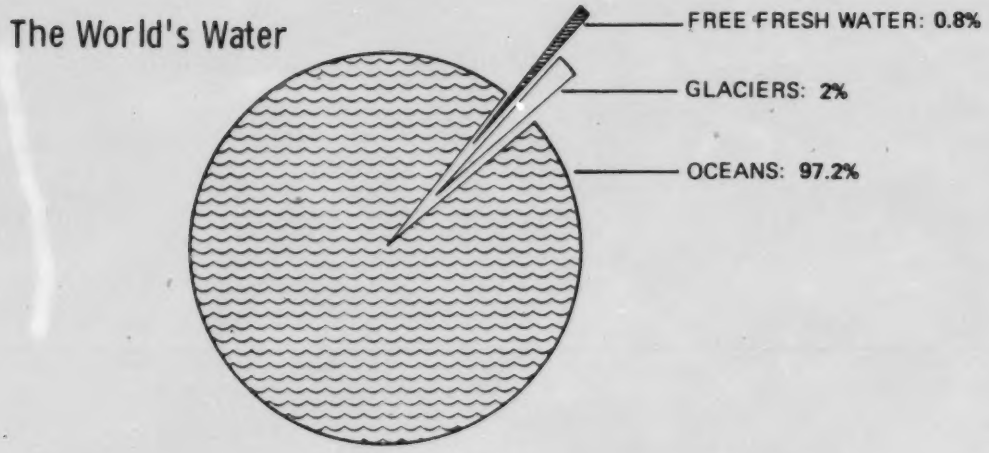


(B) A Dramatic Statement!

The world's water supply consists mainly of the salt water contained in the oceans. The world's fresh water comprises only about 3 percent of the total supply. Three-quarters of the fresh water is locked up in the polar ice caps and glaciers, and most of the remainder is found as ground water or in lakes. The very small amount of water in the atmosphere at any time is nonetheless of vital importance in weather systems.

Another way of stating the above:

Oceans hold 97.2 percent of our water.
Glaciers contain 2 percent of our water.
The rest – 0.8 percent – is available fresh water and water vapor.



Write a statement (6–4) telling what you think the **one most important use of water is**. (After writing, see page 66.)

(C) Comparison of Three Water Samples

Do the following investigations with a partner.

1. Obtain a small amount of sea water, a small amount of fresh water, and a small amount of prepared salt solution. Place a drop of each in a watch glass or on a glass slide. *Label* each: your name, specimen type, and date.

2. Set the three water samples aside so that **evaporation** will take place.

3. Examine the residue of each, using the microscope.

4. Draw what you see in each field. Make your drawings large enough so that objects can be recognized. (6–5).

5. Write a statement of your observations for the three samples. (6–6)

6. Write your statement of conclusion. (6–7)

This is a very rough method of determining the amount of salts, or **salinity**, of sea water.

(D) Current Flow and Salinity

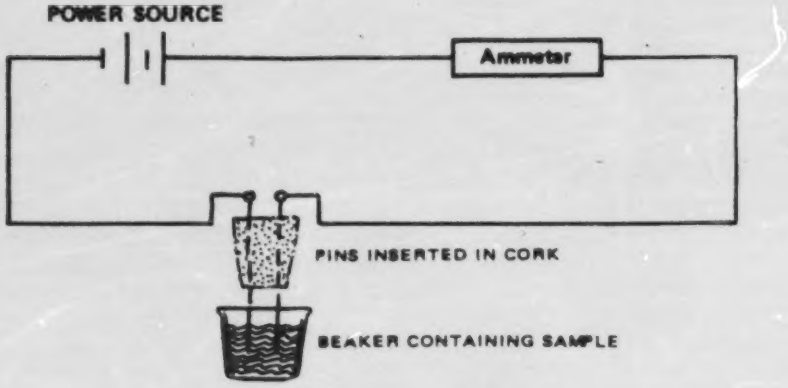
There is no question that the most distinctive feature of sea water is its saltiness, but to describe it exactly is another matter. The salinity of a seawater sample is a measure of the total amount of dissolved solid materials in the sample, and every element known to occur naturally on the earth has been found in solution (dissolved) in ocean water.

A technique has been developed to determine the salinity of sea water by measuring how much electricity a sample of sea water will conduct.

In this investigation you will look for a relationship between current-flow and salinity (percentage of dissolved salts persent).

Materials:

12-Volt battery	Beaker
Ammeter	Pin electrodes in a cork
Fresh water	Graduated cylinder, 100 ml
Sea water	Beakers, 600 ml.
4% Salt solution of water	Stirring rod



Procedure:

1. Set up the equipment as shown above.
2. Determine the current-flow of a 4% salt solution by reading the ammeter. Record. (6–8)
3. Pour 50 ml of the 4% solution into a clean, dry beaker and discard the remainder. Add 50 ml of pure water to the beaker to make a 2% salt solution. Mix it thoroughly.
4. Measure and record the current flow of the 2% salt solution. (6–9)
5. Pour 50 ml of the 2% salt solution into a clean, dry beaker. Add 50 ml of water and mix it thoroughly.
6. Measure and record the current flow of this solution. (6–10)
7. Pour 100 ml of sea water into a clean, dry beaker.
8. Measure and record the current flow of the sea water. (6–11)

Questions:

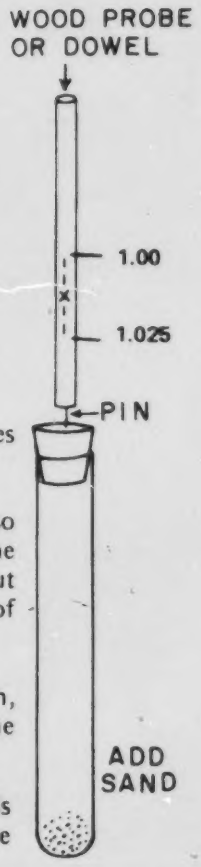
1. What percent is the salt solution prepared in Procedure #5? (6–12)
2. Plot the data of the three known salt solutions on a graph:
   Horizontal axis to be current flow.
   Vertical axis to be percentage of salt solution.
3. Place a dot on your curve for the current-flow value of the sea water. Your teacher will help you determine the salinity of the sea water by a method called interpolating.
4. What was your estimate of the salinity of sea water? (6–13)

(E) The Hydrometer

Hydrometers are instruments used to compare the densities of various liquids. Distilled water is given the standard of 1, and other liquids are related to this standard. From the density and temperature of a water sample, the salinity can be figured. (See graph, page 60.)

Materials:

Small test tube
Wooden-handled dissecting probe
One cork suitable for closing mouth of the test tube
Small quantity of sand or lead shot
Graduate cylinder with cold, fresh water



Reagents:

Various solutions of salt water

Method:

1. Insert the cork into the test tube.
2. Insert the probe into the center of the cork so that it is at right angles to the surface of the cork.
3. Remove the cork and add either sand or lead shot. Add enough so that the tube will float in the graduate cylinder with the surface of the cork beneath the surface of the water and deep enough to cover about half the length of the probe. This will take some time by means of trial and error. Don't give up!
4. When you have got the apparatus floating at the proper depth, carefully mark the probe as 1.00 at the level of the surface of the water.
5. Empty the graduate and pour in a quantity of salt water (35%) that is at room temperature. Place the hydrometer in it. Mark the level where the surface of the water now reaches the probe, and label it 1.025.

Now use your hydrometer to test the various liquids supplied. To calculate the density by the hydrometer, use a ruler to determine the distance "x" on the wood stick. If this represents a change of .025, figure the densities of other liquids by measuring how far they are from the 1.00 line (can be plus or minus 1.00). Record your results in the table (6–14) in your answer book.

Now you are to relate **density** with **salinity** and **temperature**.

Materials:

Graduated cylinder (500 ml) or similar container
Hydrometer with range of 1.000 to 1.028 (may be homemade)
Thermometer
Temperature-density-salinity graph

Reagents:

Water samples of varying salinities

Procedures:

1. Use one of the water samples.
2. Pour approximately 400 ml of the sample into the graduate.
3. Carefully float the hydrometer in the sample and read the density at the water line. The water line will be curved. This curve is called a meniscus. Read the level at the bottom of the meniscus.
4. Remove the hydrometer and insert the thermometer. Note the temperature of the water.
5. Using the graph, find the intersection of the density and temperature. Following the curved lines, read the salinity at the right.
6. Repeat with at least two other water samples. Record the salinity of each. (6–15)

Example: Temperature equals 70°F; density equals 1.015; salinity equals about 22.5 parts per thousand.

(F) Water Temperatures

Fish prefer water of a certain temperature because it provides the right amount of oxygen. Differences in water temperature cause peculiar effects for a submarine. They cause echoes and bounces of the signals sent out by a submarine, which may be misinterpreted.

The purpose of the following investigation is to observe the effect of mixing of water of different temperatures.

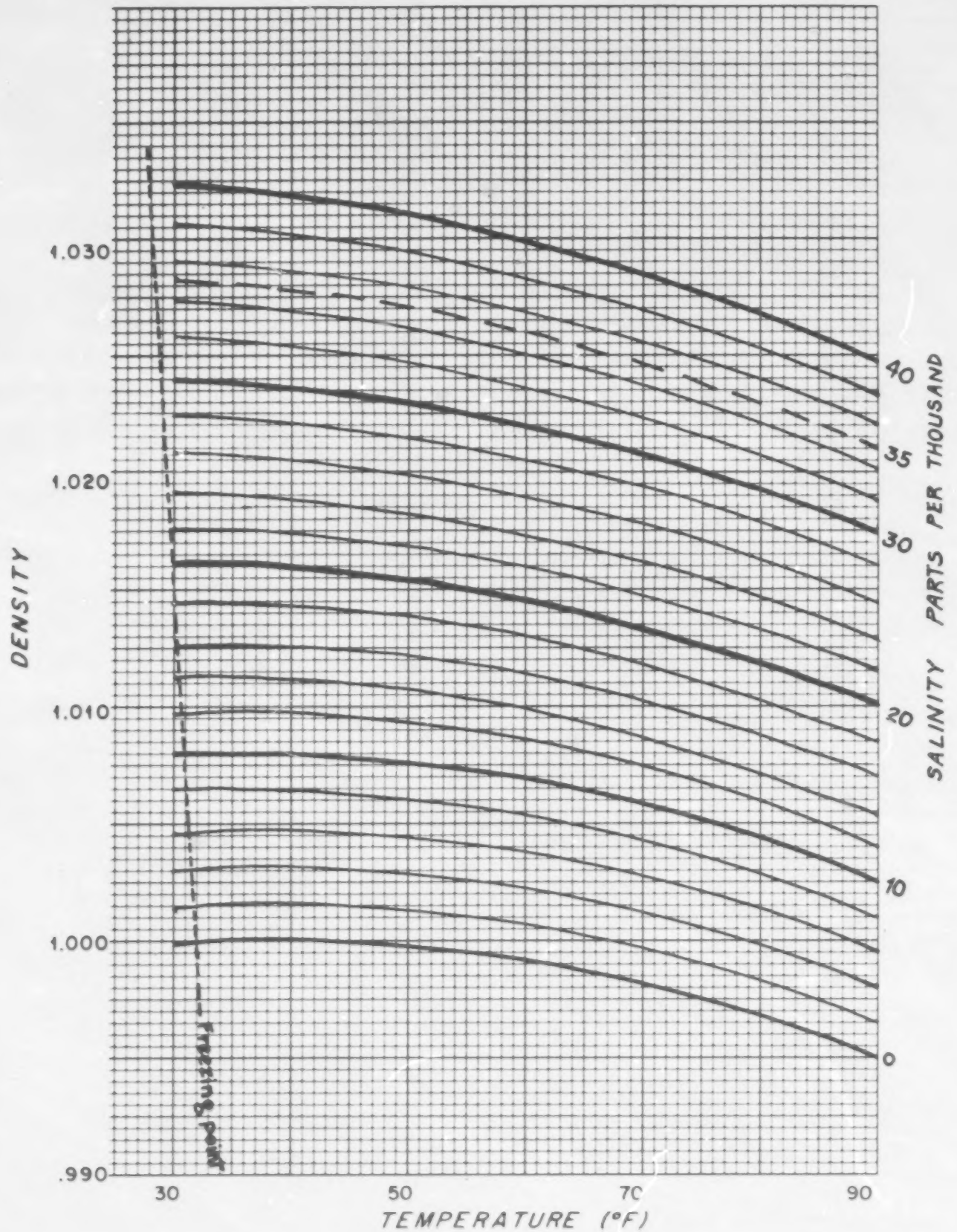
Part A

Materials:

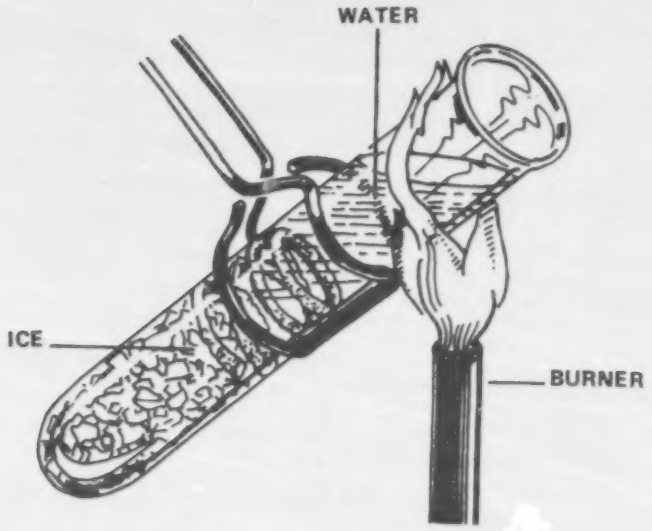
Ice	Test tube, flameproof
Pipe cleaner	Test-tube holder
Water	Burner

Procedure:

1. Crush an ice cube and push small pieces into a test tube. Fill the test tube about half full with crushed ice.
2. Wind a pipe cleaner to fit the inside of the test tube and push down on the ice.
3. Fill the test tube to about one inch from the top with cold water.


1.030
1.020
1.010
1.000
.990
DENSITY
30
50
70
90
TEMPERATURE (°F)
freezing point
40
35
30
20
10
0
SALINITY PARTS PER THOUSAND

4. Light a burner and adjust the flame. Hold the *upper* end of the test tube in the flame.



Observation:

Does the water in the upper part of the test tube boil before the ice melts? (6–16)

Conclusion.

Does water transfer heat quickly? (6–17)

Practical application:

Relate this physical property of water to its effect on the climate of the shore area in New Jersey. (6–18)

Part B

Materials:

Redtangular glass tank
Hot tap water
Cold tap water
Heavy paper
Methylene blue solution or other coloring liquid
Thermometer, Celsius

Procedure:

1. Half fill a rectangular glass tank, such as an aquarium, with cold tap water.

2. Color the cold water with methylene blue or another coloring liquid.

3. Determine the temperature of the cold water.

4. Determine the temperature of the hot water that is in a separate container. There should be the same amount of hot water as cold.

5. Slowly pour the clear hot water onto the blue cold water. Pour it on a heavy piece of paper on top of the cold water to keep the two from mixing. Do not move the tank. (Remove the paper.)

6. After 5 minutes take the temperature of the surface layer with one thermometer.

7. Determine the temperature of the water at the bottom of the tank.

8. Record your observations in your answer book. (6–19). Include original color of layers, initial temperature of each, and the condition of the layers after 5 minutes.

   Repeat steps 1–7 but place the hot clear water in the bottom of the tank and the cold blue water on the top. Record your observations. (6–20)

You have been working with liquids that have different densities because of their differences in temperature. There are definite layers of water separated from each other in the ocean because of their different temperatures. Can you think of another condition in the oceans that would produce different densities of water? (6–21)

Repeat the above experiment using layers of water of different densities but having the same temperature. Color the denser layer blue. First pour the clear water onto the blue, and record your observations under (6–22). Then pour the blue water onto the clear, and record your observations under (6–23).

You have seen that layers of water tend either to remain separated or to be inverted (turned upside down), depending on their densities. Your job now is to relate the conditions between the two layers of different densities to similar situations that exist in the ocean. Write a brief paragraph about your conclusions. (6–24)

(G) Evaporation of Water

Evaporation means literally passing off into vapor (invisible gas). During evaporation, some of the liquid water actually turns to gaseous water, or water vapor. Since some of the water is gone but all the solid matter is left behind, the process of evaporation increases the salinity of sea water.

Water evaporates from plants, animals, lakes, streams, and oceans where air and water are in contact. The rate of evaporation depends upon a number of factors.

1. The temperature of the liquid
2. The surface area of the liquid
3. The amount of vapor above the surface of the liquid (in the air)
4. Wind or other air movements

Make a prediction! (6–25) State in degrees latitude where you think the oceans are saltiest (surface waters).

Purpose:

Observe factors affecting the evaporation of water.

Equipment:

Beakers, 250 ml.
Thermometers, °C.
Graduated cylinder, 100 ml.
Balance
Marking pencil
Heat source, lamp
Fan
Refrigerator
A closed aquarium, or like apparatus
Plastic wrap
Water

Procedure:

Work in teams of six.
Record your observations on the chart in your answer book (6–26).
Do not start this investigation unless you have two consecutive days in class.
Each team member is responsible for one beaker.

1. All empty beakers are to be weighed on the balance. Record to the nearest tenth of a gram.

2. Pour 100 ml of tap water into each beaker. Record the combined weight of the beaker plus water, to the nearest tenth of a gram.

3. Observe and record the temperature of the water in each beaker.

4. Each member is to place his/her beaker in a different location.

   a. Place No. 1 beaker in the bottom of an aquarium or container that can be covered. Pour about ¼ inch water into the bottom of the aquarium. Cover the aquarium. Place the closed aquarium under a lamp (heat source).

b. Place No. 2 beaker near the lamp, but not directly under it. Air should be in motion around beaker No. 2. This can be done by a small fan, or place beakers near a ventilator.

c. Place No. 3 in the refrigerator.

d. Place No. 4 on the window sill, where it will get some direct sunlight.

e. Place No. 5 on a table in the room with no direct sunlight.

f. No. 6 beaker: Cover the beaker with plastic wrap, kept in place with a rubber band. Place No. 6 beaker on the window sill also.

MAKE SURE THAT YOU HAVE MARKED YOUR BEAKER SO THAT YOU WILL DEFINITELY KNOW WHICH ONE IS YOURS!

5. Record the time your beaker is placed in its location.

6. Leave the beakers for at least 24 hours.

At the end of the designated time period:

7. Before taking the beaker from its location, observe and record the temperature of the water.

8. Remove the beaker from its location and weigh the beaker with its water. Record on the chart.

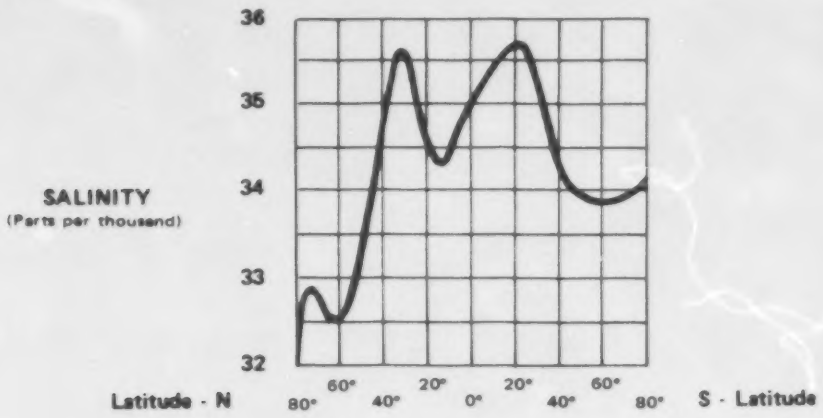
9. Compare the original weight with the final weight. Record any change in weight, whether the weight was a gain or loss.

10. Empty the water and return all equipment.

Questions:

1. What purpose did the closed beaker serve? (6–27)
2. What beaker number represented most closely conditions at 0, 20, 40, 60, and 80 degrees latitude? (6–28)
3. Beakers #1 and #2 were close to the same heat source. What was the main environmental difference? (6–29)
4. Which physical condition produced the greatest amount of evaporation? (6–30)
5. Using the investigation's results, state three environmental conditions that would dry a wet towel the best. (6–31)

The graph below gives the average surface salinity at different latitudes between the equator and poles.



6. Make a graph of your five results of water evaporation (omitting the "control"). Arrange your beaker numbers below the graph paper to correspond with 80°, 60°, 40°, 20°, and 0°, N. latitude. Select an appropriate unit on the vertical scale for plotting the amount of water evaporated. Plot your points and draw a curve through them. (6–32)

7. How closely did your results agree with the pattern of the average salinity for surface water at the various latitudes? (6–33)

Optional

After these experiments, can you think up a laboratory method for getting fresh water from salt water? Submit your proposed procedures to your teacher for approval.

(H) Questions To Ponder

1. What makes the ocean salty?
2. What are the primary pollutants found in the sea, and what are their sources?
3. Which is the saltiest ocean?
4. Has an efficient method of obtaining fresh water from the sea been invented?
5. Are there gold or other precious elements in the ocean? If so, how much?

The most important use of water (from page 55):

Life as we know it on earth is due to our abundant supply of water, which exists in a liquid form over most of the earth. If you wrote that the one most important use of water is to support life, you were right.

(I) Self Evaluation

1. List five important uses of water.

2. What do you consider the most important use of water?

3. List two factors that determine the density of water.

4. Describe two methods used to determine salinity of water.

5. If it is agreed that water resists temperature change, how might this affect a coastal climate?

6. State the atmospheric conditions that would produce the greatest rate of evaporation.

Answers to Self-Test on Water Uses

1. e
2. a
3. a
4. c
5. d
6. c
7. a (from industrial wastes and agricultural fertilizers)
8. b
9. a
10. c
11. d
12. a

Chapter VII: What Life Is There in the Ocean?

Chapter Emphasis: The ocean is an enormous ecosystem, extravagant in its support of life. The human being is at the peak of the pyramid of life.

Objectives:

1. Students will be able to illustrate a simple food chain in an ocean's ecosystem.
2. Students will be able to list the factors of importance that the salt marsh contributes to the survival of the ocean's ecosystem.
3. Students will be able to tell how the salt marshes are economically important.
4. By dissection, the student will be able to identify and describe the major adaptations of fish to their water environment.
5. Students will be able to identify the mammals that are at the peak of the ocean food chain.

Equipment:

Preserved perch specimen
Dissection set
Dissecting pan

References:

1. "Can We Save Our Salt Marshes?" Stephen W. Hitchcock and William R. Curtsinger. National Geographic, Vol. 141, No. 6, June 1972. National Geographic Society, Washington, D.C. 20036.
2. "The Nature of Oceanic Life," John D. Isaacs, in *Oceanography*. W.H. Freeman and Company, San Francisco, California. 1971.
3. *Let's Collect Shells and Rocks.* Shell Oil Company.
4. *The Outer Lands,* Dorothy Sterling. Anchor Press/Doubleday, Garden City, New York. 1974.
5. *The Sea,* Leonard Engel and the Editors of Life. From Life Nature Library, Time Incorporated, New York, N.Y. 1963.
6. *Experiences in Biology,* Evelyn Morholt. Harcourt, Brace and World, Inc., New York, N.Y. 1957.

7. *Frontiers of the Sea,* Robert C. Cower. Bantam Books, Inc., New York, N.Y.

8. *Seashores, A Golden Guide,* Herbert S. Zim, Ph.D. and Lester Ingle, Ph.D. Western Publishing Company, Inc., Racine, Wisconsin. 1955.

9. *New England and the Sea,* Thayer Shafer. Marine Advisory Service, Marine Bulletin Number 11, University of Rhode Island. 1972.

10. "Boom in Building Extracts Its Toll," from Asbury Park Press, By Ray Ollwerther, April 27, 1975.

Charts:

1. Wall charts (in color) of commercially important fish species from James Hooke Co., Inc., Boston, MA , or International Marine Publishing Co., Camden, ME.

2. "Marine Fishes of the North Atlantic," a colorful wall chart produced by National Marine Fisheries Service and available from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

Films:

1. "Plankton and Open Sea," Krasker Memorial Film Library, Boston University, School of Education, Boston, MA 02215.

2. Marine Animals and Their Food." Coronet Films, Chicago, Ill. 60601

3. "The Story of Menhaden," available free from Audio-Visual Services, National Marine Fisheries Service, 1815 North Fort Meyer Dr., Arlington, VA 22204

4. "The Hidden Treasure," Seafood Marketing Authority, 94 College Avenue, Annapolis, Maryland. 21401. (Free)

The students may want to help SAVE THE WHALES!

This campaign is supported by many conservation groups. Write to Animal Welfare Institute, P.O. Box 3650, Washington, D.C. 20007 for further information.

Have You Ever Tried A Light Show?*

An alternate method of class investigation and presentation of a study is a light show. Many students not ordinarily motivated to research a subject will be "turned on" by a visual program.

Overhead projectors, slide projectors, and music and narration can create unusual excitement.

Some students probably are photographers already and would gladly participate.

Students' slides from their home files, or slides produced by photographing pictures may be used.** Underexposed slides can have small designs cut into them, as a star or pin points to represent a constellation, for example.

Overhead projectors may have colored cellophane over the lighted face to give color. One, two, or three projectors may be used, superimposing color upon color.

How do you use the overhead projector? Stencils cut from oaktag (12 x 18 inches) using printed words, designs, or silhouettes plus prepared projection sheets can be interwoven into a dramatic statement. For a continued story, the stencils may be taped together and pulled across the face of the projector as the narration or music requires.

To effect conversation, hand puppetry can be done on the face of the projector or stenciled puppet heads with movable jaws can be used.

How does one get started?

1. Select a theme.
2. Research the subject. (This is a class project.)
3. Organize the material.
4. Prepare the visual material. (Three to four students may work on a stencil.)
5. Some students will research the desired music effects.
6. Some students will prepare the narration.
7. Some students must practice coordinating different machines for a smooth presentation.

Experiment! Turn Oceanography into a creative presentation to be shared with the entire school.

* Suggestions inspired by the Bicentennial Light Show presented by Mr. Al Kochka.

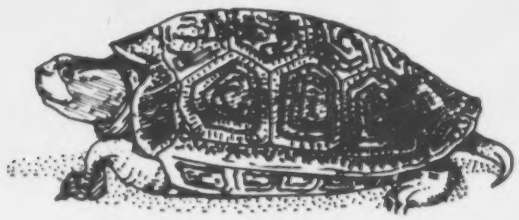
** There are commercial "Visual Makers" produced by different companies. These are primarily Instamatics screwed into a stand from about 3 to 8 inches in height and focused to take pictures of pictures at these distances.

(A) The Tidal Marsh

A good place to begin your study of life in the oceans is in the **tidal marsh,** sometimes called the **wetlands,** and often referred to as the **nursery of the sea.**

The wetlands are lowlands, periodically covered by water not more than 6 feet deep, lying between the higher lands and the sea. For years the wetlands have been considered a place to dump rubbish, build industrial plants or housing developments – a wasteland, a mosquito-filled swamp. Salt marshes are *not* wastelands but one of the most life-producing areas, usually supporting more life per acre than the richest of prairie lands.

The salt marshes are the spawning (depositing eggs) grounds for many coastal and marine fishes. Perhaps up to 90 percent of the world's edible marine fish come from these coastal waters. Foods contributing to the life cycles in the oceans have their beginning here. Marshes provide feeding and resting areas for millions of water birds, and homes for many small aquatic (living in water) animals.



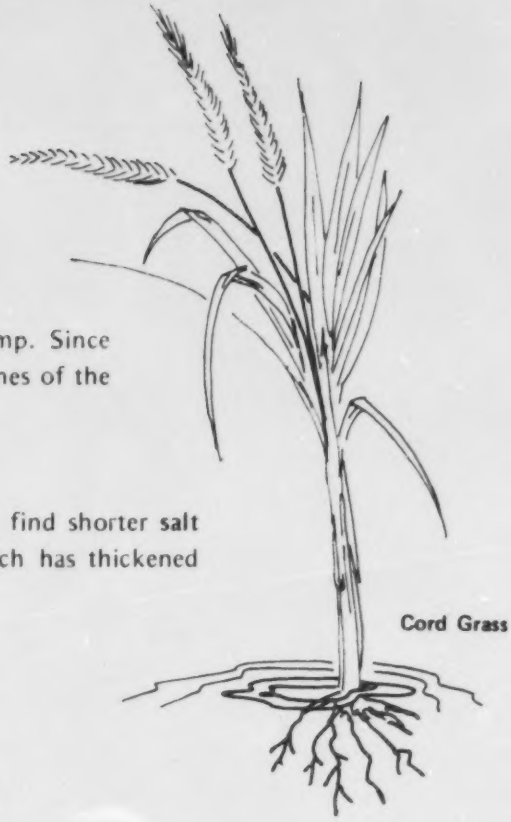
Diamondback Terrapin

The grass of the salt marsh is the basic unit of energy for life in the marsh. A few creatures eat it, many feed on its decayed matter, and others feed on the feeders. The grass of the salt marsh survives alternate flooding by sea water and exposure to dry air.

Remember the term **photosynthesis?** The green plants are producers of their own food by "locking" the sun's energy into sugar molecules. (Carbon dioxide and water are combined with the aid of the sun's energy, in the presence of the enzyme chlorophyll, into a simple sugar, glucose. The extra oxygen in the molecules is given off into the surrounding air or water.) Green plants are the *producers* of food, the *beginning* of the food chain.

Cord grass grows in the low swamp. Since few other plants can withstand the extremes of the environment, it dominates the marsh.

On higher ground you will find shorter **salt meadow hay** and **black grass,** which has thickened leaves and black, berry-like seeds.



Cord Grass

Black Grass

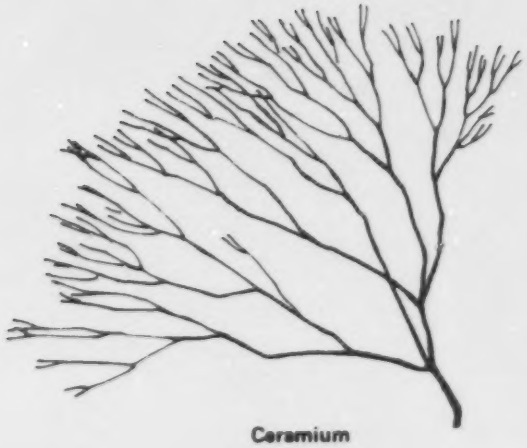
Salt Hay

Less obvious is another plant-crop which must not be forgotten – the **phytoplankton**. These are mostly floating microscopic algae. (Algae are simple plants without roots, stems, or leaves, but having chlorophyll.) These all contribute to the food energy available in the marshes.

And there are the large, leafy or branching red and green **algae** which grow in the edges of the marshes. The three main algae found on the New Jersey coast are ulva, ceramium, and fucs.

Ulva

Fucus



Ceramium

The tidal creeks of marshes are nurseries for the young of several species of fishes and crustaceans. More than sixty species of fishes have been found in the tidal marsh

streams. Small crustaceans are also abundant. The sand shrimp and opossum shrimp are in the diet of many fishes.

Shrimp

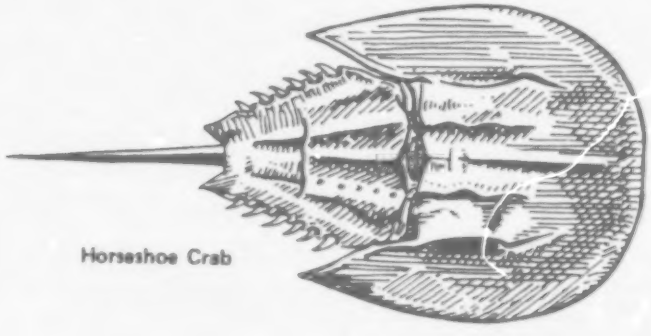
On e intertidal flats in the marshes one often finds the soft-shell clam and the razor clam. These animals filter the water through their gills, which extract oxygen and trap food.

Soft-shell Clam

Hard-shell Clam

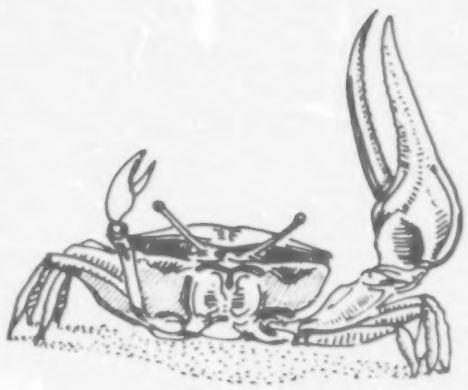
Razor Clam

These bi-valves are often eaten by sting rays and horseshoe crabs.



Horseshoe Crab

Fiddler crabs play an important role in the marsh. They eat algae and food particles in the mud and in turn serve as food for birds, racoons, and other creatures. The fiddler crabs can be found on the banks of the marsh by mounds of marble-sized soil pellets marking the burrow entrance. Their feeding activity can be compared to that of the earthworm. Fiddlers do not eat the living marsh grass, but salt-marsh grasshoppers do, and these in turn are eaten by birds, spiders, and fish.



Fiddler Crab

Marsh Snails

Ribbed Mussels

In the low marsh, the ribbed mussels are found growing in clusters around the roots of cord grass. Each mussel pumps and filters over four quarts of sea water each hour, feeding on diatoms and bacteria and decayed material in the water.

Marsh snails and periwinkles are two kinds of snails found on the cord grass. The marsh snail, small, coffee-bean colored, is an air-breather and climbs up the grass stalks at high tides to keep out of the water.

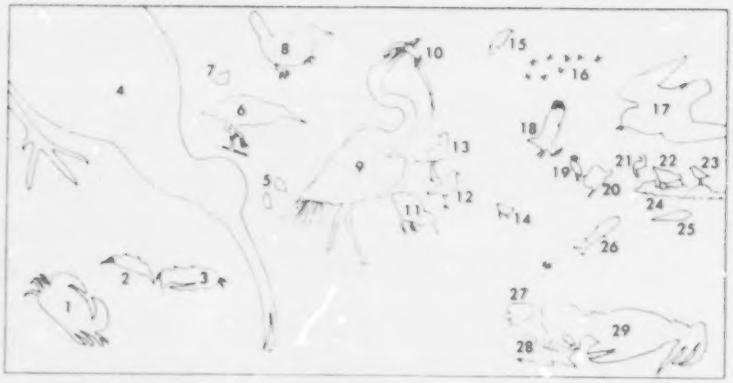
You have read a little bit about a very important ecosystem: the salt marsh. Because of the fairly shallow, protected, well-lighted water, green plants grow well. The marsh is a large, greatly cut up, sheltered, food-rich habitat which is primarily a nursery area for many species of crustaceans and fishes. The tides redistribute nutrients and sediments throughout the tidal marsh. At low tide the crabs are active on the marsh banks. In the hours of dusk, raccoons come out from the upland fringe to prey on them and the ribbed mussels. The mussels feed during the period they are covered. The salt marshes are busy places both day and night, at low and high tides!

Are the wetlands commercially important? You be the judge . . .

The following are excerpts taken from the National Geographic's article "Fragile Nurseries of the Sea," Vol. 141, No. 6, June 1972.

> Half to two-thirds of the crab commerce of the East Coast centers on Chesapeake Bay and yields six million dollars a year to crabbers there.
>
> The principal commercial fish of the East Coast is the Atlantic menhaden, which must spend part of its life in the bays and streams of the wetlands. They are processed in large plants on shore — cooked with steam, fish oil pressed out, the remainder dried and ground into fish meal for animal feed. The oil is used in the manufacturing of paints, inks, soaps, and lubricants.
>
> Nearly all the commercially valuable seafood netted in the East Coast waters owes its existence directly to the marsh. Thus does this balanced ecosystem become a factory for human food.
>
> The adults of larger, commercially valuable shrimp live and spawn in the sea, but the marsh serves as nursery for their young.
>
> Millions of birds, including those migrating along the Atlantic flyway, use the marshes as feeding grounds.
>
> Sport fishermen seeking bait buy the eight-inch bloodworm and longer, softer sandworm, which bring Maine diggers and packers some 5 million dollars gross in 1971.
>
> A fine, shorter species of salt hay, Spartina patens, is reached only by high tides. It finds use as a garden mulch . . . Attempts at diking more wetlands to farm salt hay in the 1960's damaged about 4,000 acres of marshland by disrupting the normal flow of seawater.

The above example is only one attempt of man to control this delicately balanced ecosystem.



MARSH FAUNA

1. PURPLE MARSH CRAB
2. FIDDLER CRAB (FEMALE)
3. FIDDLER CRAB (MALE)
4. WHIMBREL
5. RIBBED MUSSEL
6. GREEN HERON
7. MARSH PERIWINKLE
8. LONG-BILLED MARSH WREN
9. COMMON EGRET
10. WHITE SHRIMP
11. CLAPPER RAIL
12. BLACK-BELLIED PLOVER
13. GREATER YELLOWLEGS
14. LEAST SANDPIPER
15. REDWINGED BLACKBIRD
16. WHITE IBISES
17. SEMIPALMATED PLOVER
18. OSPREY
19. GREAT BLUE HERON
20. RACCOON
21. MINK
22. AMERICAN OYSTERCATCHER
23. RUDDY TURNSTONE
24. OYSTERS
25. RIVER OTTER
26. MULLET
27. SPADEFISH
28. ANCHOVY
29. BLUE CRAB

(B) How Well Are We Preserving the Wetlands?

The following are several examples of what has happened to the marsh lands recently:

1. Giant aircraft come and go at the John F. Kennedy International Airport, New York, which used to be a flourishing marshland.
2. An acre of well-located marsh real estate in some parts of New Jersey commands a price as high as $110,000.
3. Except for a few species of water fowl, the great flocks are gone, their habitat narrowed and polluted.
4. The marsh lands receive thousands of pounds of trash daily.
5. Each day the marsh lands are becoming more polluted by industry and commerce.
6. Recently the Asbury Park Press reported a new housing development in southern New Jersey on thousands of acres of coastal wetlands:

> It's estimated that 20,000 acres of coastal wetlands were filled in during the past two decades, much of it for the county's 13,600 lagoon homes (Ocean County) . . .
>
> One sign of Barnegat Bay's pollution is the closing of the shellfish areas by the state: about 20% of the bay's 75,000 acres of shellfishing grounds.
>
> In recent years, 'grease balls' from local sewage have been floating up along the shore.

In your answer book, write a paragraph giving your reasons why we must preserve the wetlands. (7–1)

Much of the coastal development has not followed a long-range plan. Recreational, industrial, educational, and commercial interests have competed against each other. Contractors have built many thousands of homes too close together. Now coastal-zone planners are looking off shore to the continental shelf, for new sites for oil and gas drilling. What support systems will be needed on shore? What new demands to fill in the wetlands will be made in an appeal to increase energy production? Decisions will have to be made.

Look at your own community. Make or get a map of your community. Use it to show how land is presently being used. Use different colors to depict woods, parks, residential, business, and industrial areas, pure and polluted waters, etc. Can you improve the plan? Remember that you have to provide for the community's needs for education, recreation, jobs, housing, services, businesses, utilities, and transportation. Remember that low-lying areas are easily flooded during storms, that marshes serve as nurseries for many fish of commercial and recreational value, and most importantly that man must somehow live in harmony with nature.

Do you know a city planner or a landscape architect? Ask him or her to come to your class to help you make decisions about your community.

A book that might be of help to you is "The Frail Ocean," by Wesley Marx (Ballantine Books, Inc., New York, N. Y., 1967).

(C) The Sea's Pyramid of Life

You know that the marsh lands, which are shallow, protected, calm areas, are the nurseries of the sea. Life in the open sea is fierce, with keen competition for survival. Life in the ocean is wildly extravagant in its numbers. Ocean life is often compared to a pyramid: the countless small plants and animals (plankton) are at the broad base, serving as food for all the life forms larger than they. The animals a little larger than the plankton are in turn eaten by animals a little larger than they. The chain continues until the pyramid peaks with the largest creatures of the sea. (The same sorts of pyramids occur on land.)

A single example, given by N. J. Berrill in his book "You and the Universe," reveals just how much life and death are involved in a single chain: "A hump-back whale... which is far from being the largest of its kind, needs a ton of herring in its stomach to feel comfortably full – as many as five thousand individual fish. Each herring, in turn, may well have six or seven thousand small crustaceans in its own stomach, each of which contains as many as one hundred and thirty thousand diatoms. In other words, some four hundred billion yellow-green diatoms sustain a single medium-sized whale for a few hours at the most."

A reminder again that at sea, as on land, the whole animal kingdom depends on the plants to capture the energy of sunlight and use it to make sugars, starches, and proteins that animals live on. The greatest plant crop in the entire world is the plankton, floating in the upper one hundred feet of the open sea. Though we cannot see most of them with the naked eye, we are dependent on them for our survival, as a vital part of the food chain and the prime producers of oxygen in the air.

(D) The Fish

Much of the food chain is made up of the bony fish that live in the open sea. You will study the fish as an example of a creature well adapted to its watery environment. The physical factors which may limit the fish are salinity, temperature, dissolved oxygen, the presence of poisonous substances, or the absence of a vital nutrient.

A Perch

You will work with a partner on this study of the fish.

Purpose:

To study the external and internal anatomy of a fish and the body parts that make it possible for the fish to live in water.

Materials:

preserved perch specimen
dissection set
dissecting pan

Procedure:

1. External Anatomy

Label all parts of the fish on the sketch of a fish in your answer book.

First, notice the **shape** – streamlined, cigar-shaped, to allow the fish to move through the water with little effort. The coloration is protective. The back is darker, the belly lighter. How does this help protect the fish? (7–2)

The **nostrils** are small openings in front of the eyes. These are not for breathing. What do you think is the purpose of these openings? (7–3)

Note the **operculum**, which is the conspicuous, bony covering over the gills.

Locate the following fins.

a) Dorsal fins, found on the back of the fish
b) Pectoral fins, attached to the sides, behind the operculum
c) Pelvic fins, located directly beneath the pectoral fins
d) Anal fin, behind the pelvic fin
e) Caudal fin, the tail fin

Do all fins have the same function? Write (7–4) what you think the functions of the different fins are.

A fish has marvelously refined **senses** and control organs. It has special spots sensitive to pressure and sound along the sides of its body to help guide it when there are changes in the surrounding water. The **lateral line** can be seen on both sides of the specimen. This is a sense organ.

The **anus** is the external opening of the intestine; it is in front of the anal fin.

The **urinogenital opening** is for the excretion of liquid wastes and of reproductive cells; it is found behind the anal opening.

2. Internal Anatomy

Follow the directions below for investigation of the internal anatomy of the fish. The diagram on page 25 of your answer book will help you locate the different organs.

1. **Respiratory structures**: Remove the operculum with the scissors. Several layers of fine threads are now visible. These are the **gill filaments**.

2. Each filament layer is attached to a ridge of cartilage. The fine tooth-like structures on this ridge are the **Gill Rakers**; they strain food particles from the water.

3. Place one blade of the scissors in the anal opening and cut along the belly surface to below the gills. From each end of the incision cut up to the dorsal fin. You will have a flap of loosened skin and flesh. Cut this off.

4. Probe into the mouth. The tube leading from the mouth is the **esophagus**. This enters a large white structure, the **stomach**; beneath the stomach are smaller bag-like structures known as **caeca**. The stomach leads into the long **intestine**, which can be traced to the anal opening.

5. The large whitish structure near the stomach is the **liver**. Carefully lift it and you will see the **gall bladder**, which is a small, greenish bag.

6. The **heart** is below the gills in a cavity near the head of the fish. Careful dissection will disclose an **artery** and **vein** connecting with the heart. The heart has *two* chambers. Notice the different colors.

7. The reproductive organs are **ovaries** in the female and **testes** in the male. These can be traced from the urinogenital opening to the area above the intestine. Compare your specimen with your neighbors' to observe the different reproductive organs. Check with your teacher for identification.

8. The membrane which encloses the area above the parts already observed forms the **air bladder**. This bladder can now be broken. The air bladder, filled with gases absorbed from the blood, helps the fish to keep at the proper level in the water.

9. The **kidney** is above the air bladder and connects with the urinary bladder near the urinogenital opening.

10. Carefully cut through the bone between the eyes, revealing the **brain**. White **nerve cords** can be seen if the backbone is opened; or if the brain is uncovered neatly, they can be seen most easily leading to the nostrils.

As you have probably noted by now, the fish's anatomy is similar to ours. The same organs are carrying out the same life processes. But the fish *is* adapted to live in the water. Name three adaptations to water and explain briefly the value of each for its purpose. (7–5)

What prevents food which may be in the water from passing out of the body? (7–5)

Why do you think a fish constantly opens and closes its mouth? (7–7)

What exchange of gases takes place in the gills? (7–8)

Aside from food, state three other ways in which fish are of value to man. (7–9)

(E) Mammals of the Sea

We cannot investigate life in the sea without a special mention of the warm-blooded creatures that evolved on land and for some reason returned to the sea some 50 or 60 million years ago. They still need to "come up for air" – to have their heads out of water in order to breathe.

There are four general types of mammals living in the sea, and one, the whale, has grown to be the largest of all animal forms. These animals are at the top of the pyramid of life in the sea, surpassed by only one other – a warm-blooded creature called a human being. Humans have hunted and slaughtered so many of those mammals that some have become extinct, and others are on the endangered species list of the world.

Laws now protect **sea otters**. An otter skin at one time sold for more than $1500. Of all the sea mammals, the otters have remained closest to the land, and are now often seen off the California coast.

Sea cows have become very awkward and almost helpless out of water. Some naturalists think they may be distantly related to the elephants. They are herbivorous – that is, they eat only plant food. One species of sea cow is extinct; two remain. They are the dugong of the Indian Ocean and the manatee of tropical America.

The largest surviving group of mammals is the *seals*, but their population has suffered in the last 200 years because of excessive butchering. The related walruses have been pursued relentlessly because, in addition to their hide and oil, the two-foot tusks brought a good price in the ivory market.

Of the warm-blooded animals that have returned to the sea, none has adapted more completely, or been more remorselessly slaughtered by people than the whale. Many whales are on the endangered species list, and most countries are observing an international agreement to ban commercial whaling.

Closely related to the whale are the porpoises and the highly intelligent dolphins. These too are endangered because they "lead" fisherman to schools of tunafish and then get caught in the nets and drown. Modern methods of tuna fishing have been devised, however, that permit most dolphins to escape. Perhaps this is one problem that will be solved in the not-too-distant future.

(F) Questions To Ponder

1. What causes the red tide?
2. How many species of fish are there?
3. How do oysters produce pearls?
4. Is seaweed a weed? What is it and how does it grow?
5. Is life found at all depths of the ocean?
6. What is bioluminescence?
7. Is there any danger of overfishing?
8. What types of organisms, other than sharks, are potentially dangerous to swimmers?
9. How much electricity does an electric eel generate?
10. How can algae be plants if they have no roots, stems, and leaves?

(G) Self Evaluation

1. What is the base of all marine food chains?
2. Identify three ways the salt marshes support life in the ocean.
3. Identify two ways the salt marshes are economically important to man.
4. List three adaptations of the fish to its watery environment, giving the functions of each.
5. Identify four different types of mammals that have evolved as sea creatures.
6. Construct a food web illustrating the inter-relationship of all the organisms in the web. You may wish to do some additional research before you complete this project. Remember that the relationship of who eats whom in nature is a complicated one. The producers make the food, and the consumers eat those foods or animals available. To get you started, minnows eat plankton . . .

Chapter VIII: A Field Trip To Sandy Hook, New Jersey

Chapter Emphasis: The students will become acquainted with the shore area with the help of classroom preparation. This chapter specifies Sandy Hook, but the trip could be taken to any shore area – if possible one which has both a bay and an ocean side. Preparations will generally be the same for any field trip to the shore. The following are some suggestions.

1. Students should sign up for the trip, naming a **buddy**. Buddies should be responsible for each other at all times. No one should be off alone. Name tags could be used if adults are going who are not acquainted with the students.

2. **Collecting bags** are appropriate for beachcombing. Brown paper bags are unsuitable. Plastic bread bags or small refrigerator bags have proven most satisfactory.

3. **Dress** should be suitable for the time of year. Temperatures at Sandy Hook are usually cooler than on the mainland. Extra socks and pants for those who will be wearing waders are a must. Heads and hands should be protected in the cooler weather. If it is cool, sneakers are the least desirable. Suggest that the students dress in "layers" in case of change in temperature, rather than in one bulky outer garment.

4. **Poison ivy** is everywhere except in the paths. Every attempt to limit the presence of this plant in areas used heavily by the public has been taken, but reasonable caution should be taken for allergic students.

5. **Clipboards** are suggested. These can be a commercial product or homemade. Be sure that students can control their papers. It usually is windy.

6. **Permission slips** are necessary.

Objectives:

1. Students will be able to list three physical properties of water which determine the types of life in that area.

2. Students will be able to state the general procedure for on-site tests of these physical properties.

3. Students will be able to state the general procedure for all field testing.

Equipment:

Equipment needed for the field study is given under the individual investigations.

Field testing kits, such as the Hoch kits, are a great asset to a water-testing program. Their ease of use in the field is good. Dissolved oxygen content is an important item; hardness determination is a simple procedure; CO_2 content can be identified as well as the phosphates, nitrates, hydrogen sulfides. Different kits have simple to more complex reading instructions and procedures.

Facilities:

If Sandy Hook is a convenient site for you, there is a teacher-training program in field study at Sandy Hook given by the Community Services Department, Brookdale Community College, Lincroft, N.J. If a teacher is certified after a short training period in the field studies, many facilities become available to you. There is a fee for the use of the on-site trailer lab, waders, seine nets, plankton nets, shovels, forks, bay-bottom seives, buckets, microscopes, pans for algae mounting – to name only some . . .

Films:

1. "Beach – A River of Sand. Color, 20 min. Encyclopedia Britannica Films, 202 E. 44th Street, N. Y.
2. "Life Between Tides." Color, 11 min. Encyclopedia Britannica Films, 202 E. 44th Street, N. Y.
3. "Marine Biologist," Color, 12 min. Encyclopedia Brittannica Films, 202 E. 44th Street, N. Y.
4. "Plankton and the Open Sea." Color, 18 min. Encyclopedia Britannica Films, 202 E. 44th Street, N.Y.

A special note of thanks to J.R. Gardella, formerly of Community Services, Brookdale Community College, Lincroft, N.J., who developed the field studies which have been adapted for this curriculum.

If you are interested in building your own marine-sampling equipment, there are some general hints about many pieces of equipment in a booklet available through the New England Marine Resources Information Program, Narragansett Bay Campus, University of Rhode Island, Narragansett, R. I. 02882.

Chapter VIII: A Field Trip to Sandy Hook

-- Classroom Preparation--

On this field trip to the Sandy Hook unit of the Gateway National Recreation Area, you will pass through several ecosystems. An ecosystem is where air, land, living things, and water are all interacting. You will travel from an urban area to the coastline. You will inspect the bay side, the salt marsh, the mud flats, dunes, and climax holly forest. Not only will you become acquainted with these ecosystems, you will by direct experience be performing technical tasks of geologists, hydrologists, marine biologists, and naturalists – to name a few. You will explore and compare an ocean and bay shoreline. You will collect plankton and small marine animals, algae, sand, shells, cored samples of various soils, and water samples, and bring much of this back for laboratory study in the classroom.

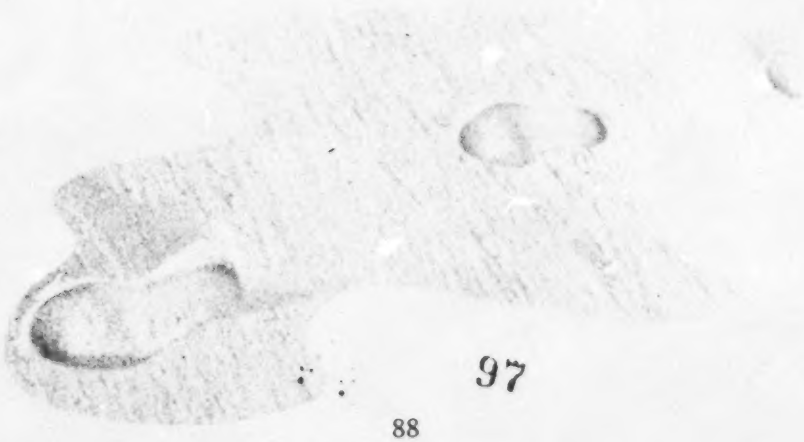
You will use all your senses investigating these environments. Above all, a scientist is a keen observer!

Where Is Sandy Hook?

Sandy Hook is the most northerly section of New Jersey's oceanfront. It lies 16 miles south of Manhattan Island (New York City) and 15 miles east-southeast of Perth Amboy, New Jersey. Sandy Hook is a peninsula 6 miles in length and about 1800 acres in area. It has a neck only a few hundred feet in width, and is just about one mile across the widest point. The whole area seems to have been built up over the centuries by the deposit of sand carried northward along the coast by the waters of the ocean. The swampy areas are only slightly above sea level, but most of the land is from 10 to 15 feet in elevation. Some of the sand dunes exceed 25 feet in height.

The shoreline of Sandy Hook, with it ocean and bay beaches, coves, points, and bays, is intriguing. The contour of the land and the plant life on it add interest to the area. Hackberry, holly, dune grass, poison ivy, Virginia creeper, and beach plum are abundant.

While emptying your shoes of the gritty particles, have you ever wondered . . . *What is sand? Where does it come from? Is it the same on all beaches?* You can't answer these questions while you're letting it sift through your fingers. Fill a container with some sand, seal it, and label it. Bring it back to school for laboratory study, and hopefully one or more of the questions will be answered through laboratory investigation.



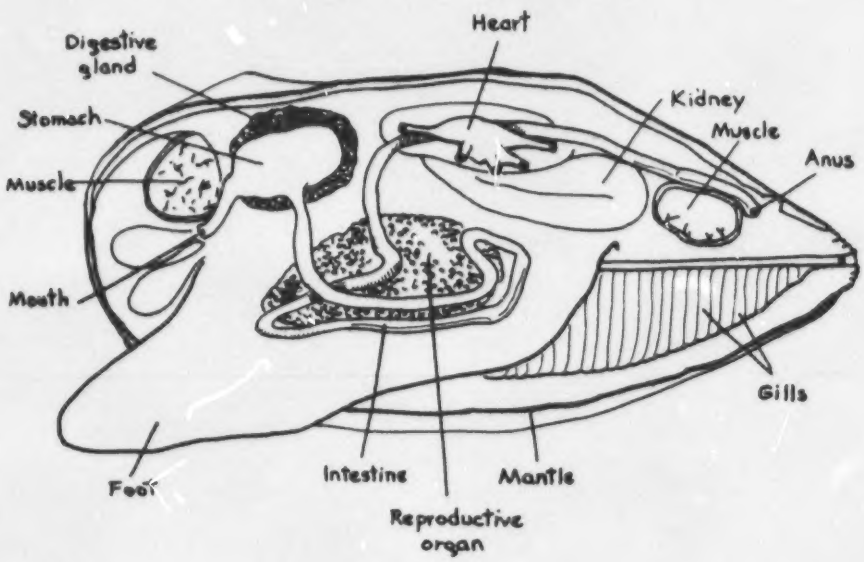
(A) The Mollusks

The mollusks are soft-bodied animals, mostly aquatic (water-dwelling), and most have hard shells surrounding their soft bodies. There are about 80,000 different species of mollusks!

Mollusks live their lives in their shells, burrowing into mud or sand, or fastening themselves to rocks. A mollusk builds its "house" of calcium, and it has a great instinctive talent for color and sculpture! Mollusks lay millions of eggs.

When you find a shell on the beach, you are looking at the skeletal remains of a once-living soft-bodied animal.

Major Organs of a Typical Bivalve



Partial Anatomy of a Typical Univalve

(B) Long-Shore Current

While looking at the foaming waters at the shoreline, you might notice the angle at which the waves hit the shore, and the rate of wave action.

What is long-shore current? How fast is it here? Does the current always flow in the same direction?

In a team of six you can help answer the above questions by a simple experiment. Scientists study currents in many ways. One method they use is to place objects that float either on or under the surface of the water and follow their path. An object floating in a current will move only as fast as the current.

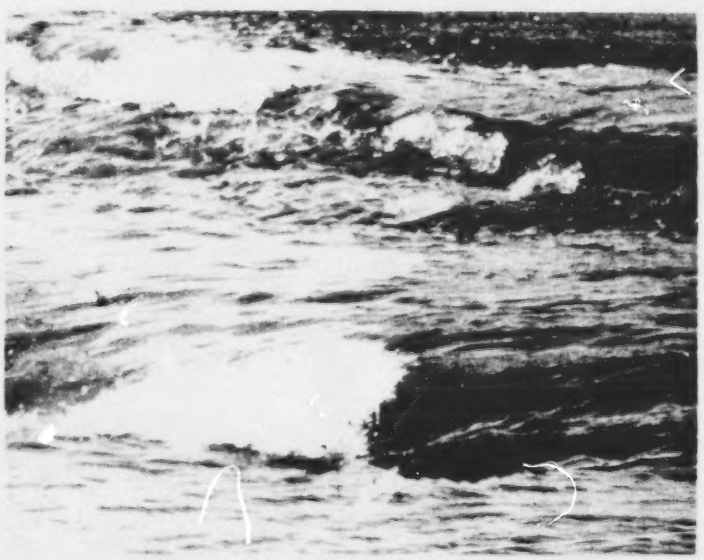
Oceanographers use the following formula:

$$\text{Velocity} = \frac{\text{distance traveled}}{\text{time to travel distance}}$$

For example, if it takes 20 seconds for an object to travel 200 feet, its velocity is

$$V = \frac{200 \text{ feet}}{20 \text{ seconds}} = 10 \text{ feet per second}$$

You will measure a distance along the shore and will time a floating object in the current to obtain the speed. Follow the instructions on the Current Study Sheet in your answer book (page 27).



(C) What Can the Water Tell Us About This Site?

You learned in Chapter VI that water varies, depending upon its location and its interaction with the atmosphere.

Dissolved oxygen in the water, the saltiness (affecting density), and temperature are three physical factors which determine the types of organisms that may live in the water. Of course, we now have also to consider pollution and its effect on life in the marine environment.

The total amount of dissolved mineral solids in sea water is called the **salinity**. Salinity is usually given in parts per thousand ($^{o}/_{oo}$). The average reading for the ocean is 35 $^{o}/_{oo}$. Salinity is one of the major limiting factors of the marine environment. Different marine animals have different tolerances for salinity – the minimum and maximum amounts they can survive in. This factor limits the diversity (number of different types) of sea creatures in many areas.

You will determine the salinity of several sites, with special emphasis on comparing the ocean and bay sides of the peninsula. Two methods may be used:

1. The hydrometer (the one you made during Chapter VI study or a commercial one).
2. A salinity field kit. (Be sure to review the instructions in the kit before the field trip).

The equipment needed and procedure is listed on your field-study sheet titled "Salinity Determination" (next page).

Record the data on the data sheet for both ocean and bay sides. (page 28)

A test for **dissolved oxygen** in the water is very important. All organisms require oxygen in order to live. The field kit may be used. Again, remember to review the instructions included with the kit before you are at your test site.

Record your results on the data sheet for ocean and bay sides. Also notice the **turbidity** of the water and record it on the same sheet. The turbidity means how clear or cloudy or even muddy the water is.

Field Study – Salinity Determination

Field equipment:

Salinity field kit (Hoch kit, or the like)
Paper and pencil
Cylinder
Thermometer (Celsius)
Density table

Procedures:

We will use two methods of salinity determination: density and titration. The titrating will be done with a salinity field kit which has instructions included. The density calculations are done with a hydrometer.

Fill the cylinder to about one inch from the top. Grasp the hydrometer at the top and insert it into the cylinder slowly to avoid wetting the stem. Impart a slight twirl to the hydrometer and note the reading as it comes to rest. Be sure to keep the float away from the sides of the cylinder while reading.

Read the number on the hydrometer which is at the surface of the water. This is the density reading. Take a temperature reading using a Celsius thermometer. This temperature is used for correcting the density. The hydrometer is calibrated at 15°C. For every 3°C that the temperature is above 15°C add 0.001 to the hydrometer reading, and for every 3°C that the temperature is below 15°C, subtract 0.001 from the hydrometer reading.

Field assignment:

1. Collect samples of water from the ocean side and the bay side.
2. Determine the salinity of each sample, using either the kit or the hydrometer and a density-temperature-salinity chart.

(D) Plankton

Collect **plankton** from both the ocean and bay sides. Remember, the term "plankton" refers to those plants and animals, mostly microscopic or near-microscopic in size, which float or weakly swim about in the water. All forms of life depend on them either directly or indirectly.

Measure and record the diameter of your plankton net. To calculate the distance you will need to tow in order to sample 100 cubic meters of water, you will use the formula for calculating the volume of a cylinder.

$$V = \pi r^2 D$$

where V = volume of water = 100 m^3
r = radius of net (half the diameter) in meters
D = towing distance

$$100 = \pi r^2 D$$

$$D = \frac{100}{\pi r^2}$$

You will tow the plankton net at the depth to be studied for the calculated distance. Pour sample into collecting bottle, cap, and attach identification tag telling location, time of day, and depth at which collected. After the samples are collected and labeled, they may be kept in a refrigerator (do not freeze) up to a week or preserved for later study in a mixture consisting of 50 parts of sea water to one part formalin.

You will study the plankton later in the classroom.

(E) Investigation of Benthic Life

If you have a corer you may be able to investigate the benthic life of the bay bottom. "Benthos" means all the bottom-living organisms which crawl on the floor of the body of water, burrow into it, or are permanently attached to some object. When coring, insert the pipe to about 30 cm, the depth at which most benthic life ceases.

To find the volume of the sample, use the formula to find the volume of a cylinder

$$V = \pi r^2 \times \text{depth}$$

Push the sample out carefully and mark off each ten centimeters.

Count the number of individuals and number of species in each of the 10 cm cores.

Express the numbers relative to cubic centimeters at each depth.

Record your results on the Benthos Data Sheet. Several samples should be taken at each site for greater accuracy within the same substrate (type of bottom).

(F) Have You Ever Seined for Small Plant and Animal Life?

You will be surprised at the variety and quantity to be found.

Use a seine net in shallow water (about 1 meter or less). Two students hold the poles so the bases are on the bottom and inclined forward, then walk the seine slowly through the water, keeping the lead weights on the bottom and the floats on the surface. After fishing, walk the net close to shore, quickly fold the net lengthwise to enclose the fish, and then lift it ashore. If there is no bank, the net may be run right onto the shore. Of course the students in the water must have waders.

For every two students in the water, there must be at least two students on shore with plastic buckets partially filled with sea water. The Seine Data Sheets (page 30 of answer book) should be at hand in order to record the numbers and types of specimens caught. It is also necessary to record the conditions for the seine catch. See the Seine Data Sheet so that you will know what measurements should be taken.

The specimens may be carried back to school in plastic buckets, plastic bags, or jars. Be careful not to overcrowd your containers.

You will have many follow-up activities in the classroom.

(G) Study of Mollusk Sizes

Commercial "farmers" of mollusks (clams, oysters, etc.) select carefully the sites where they will cultivate their crops of mollusks. You have an opportunity now to undertake a population study of a mollusk, the common blue mussel, to determine if different habitats result in the development of different size ranges.

Collect samples of mussels from two different sites. One should be an exposed rocky area and the other a protected spot, such as a mud flat or salt marsh. Place the samples in separate containers, each with the sea water from the site of collection. Label each with the date and site, and take to the classroom.

(H) Collect Some Algae

If your trip is at low tide, you will find greater quantities of algae. You might have to do a little wading, so waders or at least waterproof boots would be helpful. Scan the water's edge carefully, for the more delicate and more beautiful algae easily escape notice.

Place specimens in plastic buckets containing a small amount of seawater. Groups of coarser algae may be wrapped in cheesecloth or wax paper. In addition, smaller or more delicate forms should be placed separately in plastic bags or vials and kept in buckets separate from those for coarser algae. Store buckets in the shade, never in the sun. Rinse frequently with fresh seawater. As with the small animals, do not overcrowd. Many beginning collectors are surprised to find that algae can deteriorate quite quickly. If it is a particularly warm day, you may use an ice chest to keep the algae specimens cool.

Directions for mounting the algae will be given in the next chapter.

(I) Self Evaluation

1. Identify three physical factors of water which determine the type of life in that area.
2. Plankton will be gathered by a net and stored in a small jar. State your definition of plankton.
3. The velocity of an off-shore current can be determined by what two measurements?
4. To find the volume of a cored sample of substrate what formula do you use?
5. When seining, list five factors which must be recorded on your seine data sheet and the instruments used to determine each.

Chapter IX: Investigation of Field-Trip Specimens

Chapter Emphasis: Emphasis should be placed upon the interaction of the air, land, water, and life in the ocean ecosystem: the dependency of one on the others.

Objectives:

1. Given a slide with planktons, students will be able to roughly identify three major groups.

2. Students will be able to identify the life processes of the fish and the organs responsible for them.

3. Students will be able to graph the relationship of the fish's oxygen consumption to water temperature.

4. Students will be able to state a relationship between the size of blue mussels and the site of their growth, from their own study.

5. Students will be able to identify four major sand-particle types and the general source of New Jerseys' beach sand.

6. Students will be able to graphically display the differences in the physical properties of water between the ocean side and the bay side.

7. Students will be able to generally identify common types of algae and display them properly labeled.

References:

1. *Seashores, A Golden Guide,* Herbert S. Zim. Ph.D. and Lester Ingle, Ph.D. Western Publishing Company, Inc., Racine, Wisconsin. 1955.

2. *Biology Teacher Handbook,* J. J. Schwab. J. Wiley and Sons, New York, N. Y. 1963.

3. *Laboratory Experiences in Marine Biology for Upper Elementary and Secondary Grades,* Roger J. Raimist. U. S. Department of Health, Education and Welfare, Office of Education. 1967.

4. *Plankton.* Fishing Leaflet 583, U. S. Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries.

Chart:

Marine Plankton Primer. A well-illustrated 10-page booklet accompanied by a large wall chart. Martek Instruments Inc., 879 W. 16th Street, New Port Beach, California 92660.

Note: For the investigation of sand, samples should be gathered ahead of time. Binocular scopes would be ideal for observation, but lacking these, hand lenses or monocular scopes could be substituted. Jar lids do well to hold the samples of sand unless you are using the monocular scope.

(A) Plankton

Procedure:

Examine some typical phytoplankton (plant-like) and zooplankton (animal-like) on the next few pages.

Place a small quantity of plankton in a petri dish and examine them under the binocular scope. Sketch enough detail to aid in identifying them, estimate the size of each organism, and record. (9–1)

Prepare a wet mount of the plankton and examine under the low power of the monocular scope. Make sketches and size estimates of types of plankton visible in the previous observation. Label as many recognizable forms as possible and group. (9–2) See the plankton diagrams on the following pages. What is the ratio between plants and animals? (9–3)

Plankton exist in the oceans of the world, in seas, bays, lakes, and in every natural water body, a population of living organisms so immense in numbers that it defies counting. Plankton are involved in the food chains of all marine animals. Diatoms keep the surrounding water supplied with oxygen and, indeed, are our major source of atmospheric oxygen.

If a major source of plankton growth was stopped by pollution, list at least three consequences. (9–4)

PHYTOPLANKTON
ALGAE

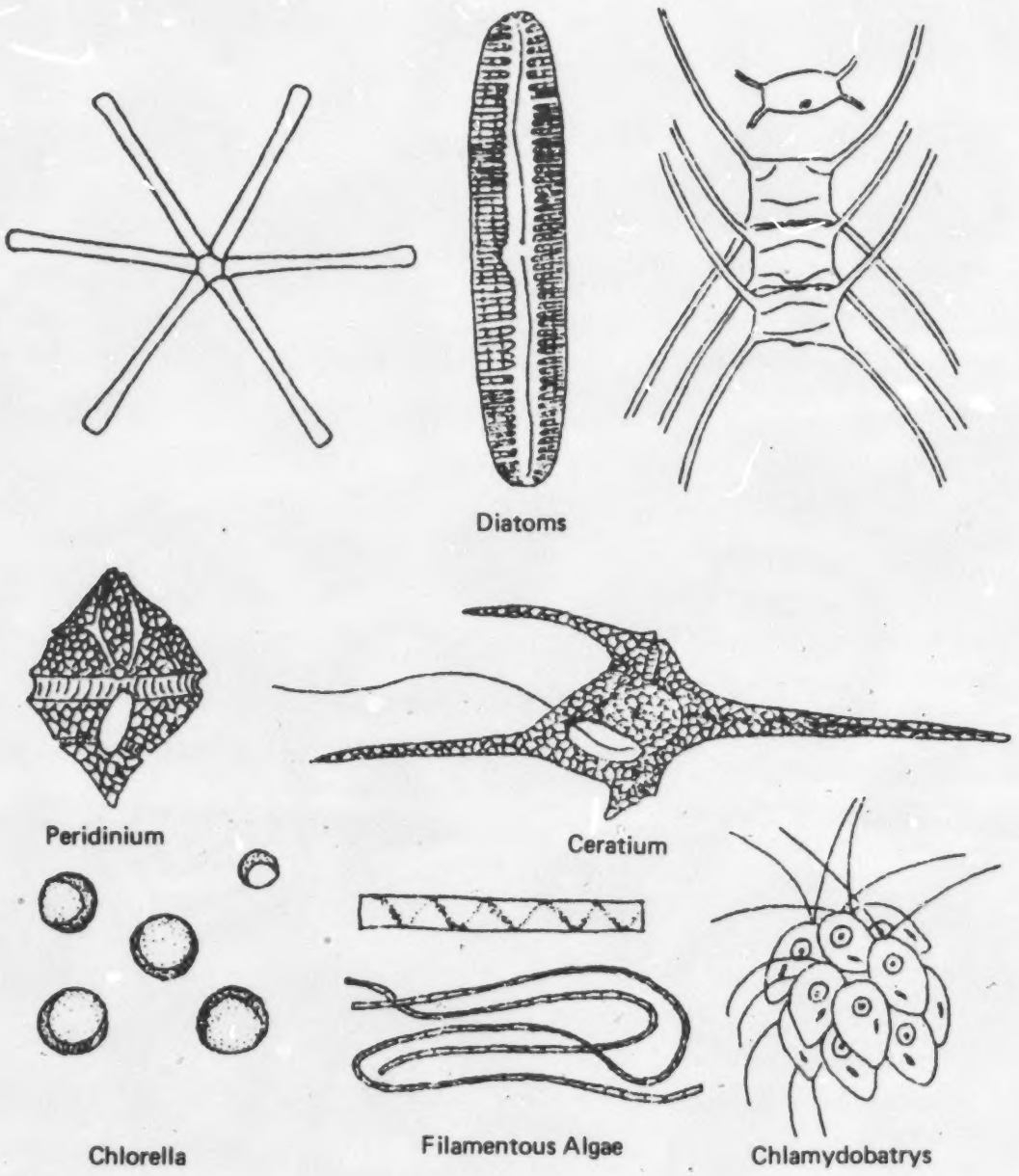
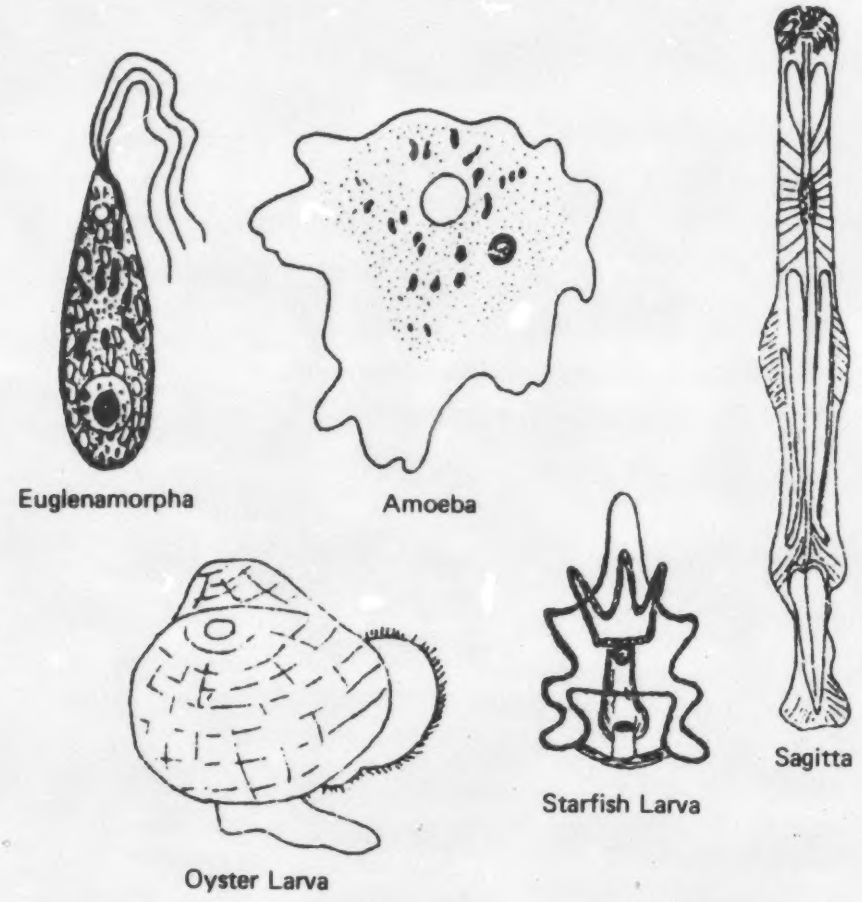


Figure 1. – Some typical forms of phytoplankton (greatly magnified): Peridinum and Ceratium (dinoflagellates), Chlorella (chlorococcales), Chlamydobatrys (volvocales).

Plankton diagrams are from a booklet "Plankton," issued by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

INVERTEBRATE ZOOPLANKTON



VERTEBRATE ZOOPLANKTON

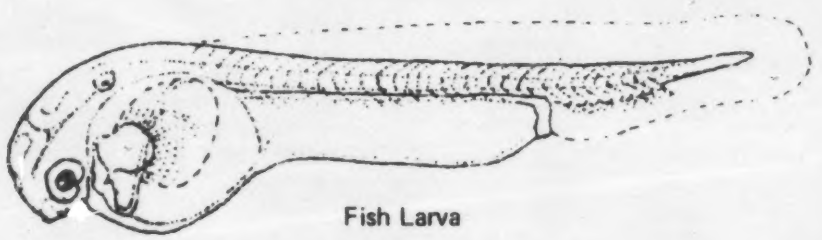


Figure 2. – Some typical forms of invertebrate and vertebrate zooplankton (greatly magnified).

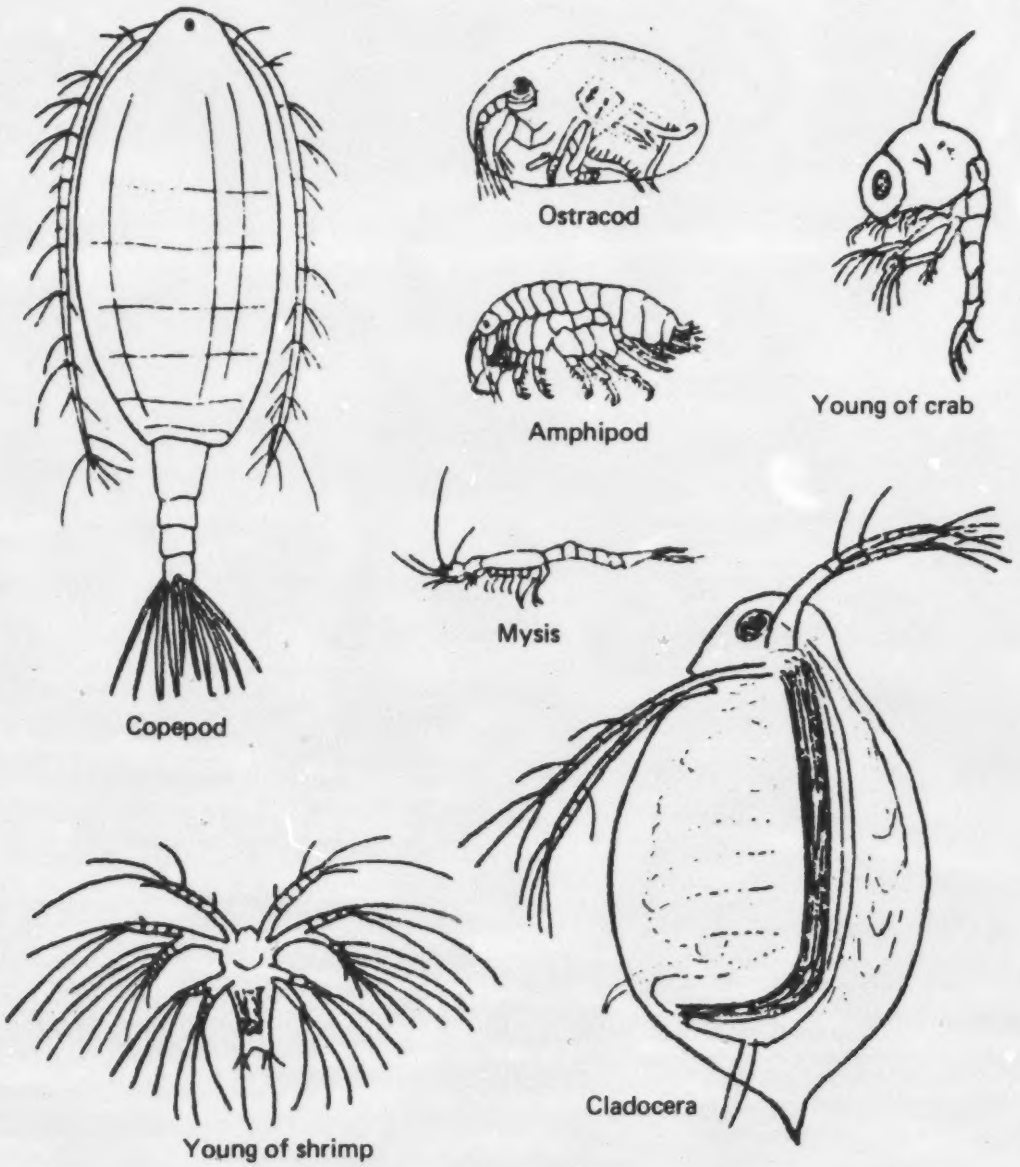


Figure 3. – Invertebrate zooplankton (greatly magnified).

(B) Common Blue Mussel

Study of the common blue mussel to determine if different habitats result in the development of different size ranges.

Procedure:

Examine the separate samples brought back to the classroom. Remember to keep the two samples from the different habitats separate. Describe their general characteristics. To what broad classification do they belong? (9–5)

What purpose is served by the threadlike structure which you will notice on many of the specimens? (9–6)

To classify according to size, identify the smallest mussel and the largest mussel. On your mussel data sheet the lowest size range should include the smallest mussel, and the highest size range should include the largest mussel. Choose size ranges so that you will have four or five steps. Record the total in each size range on the Mussel Data Sheet in your answer book. (9–7)

Choose a size range of four or five steps (example, 0.5, 1.0, 1.5, 2.0, 2.5, etc.) suitable for size-grading of the samples. Record the total in each size range on the Mussel Data Sheet in your answer book. (9–7)

After you have completed the tabulation of mussels, compare the two habitats. Did you find a size-range difference in the two samples? (9–8) If so, how might you account for this? (9–9)

(C) The Circulating Blood in the Fish

Now turn your attention to the fish in the aquarium. Have you identified all of them? It is interesting to note that the fish, a simple vertebrate, carries on the same life processes as we do. Notice how often the fish opens and closes its mouth. What *two* life processes are involved in this action? (9–10)

Where does the water escape after it enters the fish's mouth? (9–11)

What structures prevent food from escaping with the water? (9–12)

Look for the gills. What gives them their color? (9–13)

Name two substances that pass through the membranes of the gill filaments. (9–14)

Bring a net near the fish. How does the fish react? What part of the fish is specialized in sensitivity and initiating reactions? (9–15)

When you dissected the fish earlier, you inspected its two-chambered heart and assumed a circulation of blood. Now that you have many specimens from the field trip, let's take a look at the **fish's circulating blood.** Wrap the body and head of a small fish in absorbent cotton dipped in aquarium water, and lay the fish in a petri dish. Add a little aquarium water, flatten the tail, and lay a slide over the tail to keep it flat. (Keep the surface of the slide dry.) If the tail flips, dry the slide and replace it on the fish's tail.

Place the dish on the stage of your microscope so that the fish's tail is centered. Examine under low power. Look first for two large blood vessels in which the blood is moving in opposite directions. Then look for the smaller blood vessels which crisscross between the larger vessels.

Carefully turn to high power and look for blood cells in the blood stream. Sketch what you can see. (9–16)

Do you know what two important materials diffuse out of the blood vessels into the cells? (9–17)

What cell wastes diffuse out of the cells into the blood vessels? (9–18)

(D) Oxygen Consumption of Fish

On the field trip you tested the water for dissolved oxygen, knowing that all organisms need oxygen for survial. You will now carry out an **investigation to measure the oxygen consumption of a fish** at varying temperature conditions. The one variable is temperature. You can observe the effects of temperature on respiratory rate.

Procedure:

1. Fill baby-food jar three-quarters full with aquarium water.
2. Weigh the jar and water.
3. Place the fish in the jar and weigh again
4. Subtract the weight of #2 from #3 to obtain the weight of the fish. Record the weight of your fish under column #1, table for Measurement of Oxygen Consumption. (9–19)
5. Observe the temperature of the water and adjust to prescribed temperatures by either adding ice or gently heating beaker.
6. At specified Celsius readings, observe the number of operculum beats per minute. Record. You will have six recordings under column #1.
7. Record your classmates' data under columns 2–10.
8. Add the total number of beats for each temperature reading and record under column A.
9. Add the total weights of the fishes and record under Column B.
10. Record the total beats/total weight under Column C.
11. From these figures in Column C you can compute the average number of beats/minute/g of body weight. Record under Column D.
12. How close were your own figures to the average?

    (This does not give an absolute value for the amount of oxygen consumed but only a number directly related to the oxygen-consumption rate.)
13. State your conclusions as a result of this experiment. (9–20)

This is an example of how an organism is directly related to its environment. Temperature and dissolved oxygen are two physical properties of water that determine survival of life in that environment.

What kinds of pollution would change both of these properties of water? (9–21)

(E) Sand Study

Part of the environment we tend to take for granted when we go to the shore is the sand. Have you ever wondered where sand comes from? Have you visited different beaches and observed that each beach has sand that is different from that found in other areas? Let's examine various samples of sand and try to determine a pattern in their differences.

Some helpful background information might be to identify the four major particles found in sand:

quartz (clear)
hornblende (dark green)
feldspar (orange-pink)
mica (shiny black, containing iron)

1. Sand sample "A" was found in a mountain stream. Describe what you see according to colors and size of particles ("pebbles," "sand," "powdery substance"); give an idea of the percentage of the different colors and sizes of particles. (9–22)
2. Sample "B" is Sandy Hook beach sand. Compare colors, sizes, and quantities of the different particles with sand sample "A." (9–23)
3. Sample "C" is Island Beach sand. Describe as above and compare with the others. (9–24)
4. Sample "D" is Cape May beach sand. Also describe as above. (9–25)
5. Which of your sand samples had the largest crystals? (9–26)
6. Which of your sand samples had the smallest crystals? (9–27)
7. State the pattern of differences among the sand samples. (9–28)
8. Take a look at a topographic map of New Jersey. Where do you think is the source of most of the shore's beach sand? (9–29)

(F) Mounting Algae

Equipment:

Shallow pan, 13" x 9" minimum size
Ditto paper (or other glossy paper)
Waxed paper
Dissecting probe and/or camel's hair brush

Procedure:

1. Fill shallow pan half full of water.
2. Place glossy paper in pan and submerge.

3. Select algae you wish to mount.

4. Place algae in pan of water and as they float, bring paper up under them. Arrange algae in best pattern on paper. (Both paper and algae are still in pan of water).

5. *Gently* lift the paper out of the pan by drawing it over one end of the pan. As the water drains from the paper, the algae will shift their arrangement. You can correct this with the dissecting probe or camel's hair brush.

   Be patient! If the algae clump too much, submerge both paper and algae and try again.

6. Now that your paper with "disarranged" algae is out, place it on a heavy thickness of newspaper. With the dissecting probe or camel's hair brush, place the algae to best advantage.

7. When you're satisfied with the arrangement, place a piece of waxed paper over the algae.

8. More newspaper should be placed on top of the waxed paper.

9. Press your algae until the glossy paper is completely dry. This will take at least two days.

10. When the paper is completely dry, gently peel off the waxed paper. The algae will naturally stick to the glossy paper, and you have now a preserved specimen, attractive, ready to be labeled and matted, if desired.

If you really like the results, try mounting the algae on a better grade of paper, matting and framing the specimens.

The pressed and mounted algae can also be used for **placemats.**

1. Cut a backing material (mounting paper) the desired size and shape of the placemat.

2. Cut two pieces of self-stick clear plastic ("Contac" paper) 1 inch larger all around than the backing material.

3. Cover the front, then the back of the mounted algae with the clear plastic. Be sure to firmly press the overlapping edges of the clear plastic together to form a seal.

4. Trim the sealed plastic edges slightly to form an even, finished edge. Leave at least ½ inch of sealed plastic around the paper so the placemat can be washed without danger of water's leaking into the backing and pressed algae.

The above procedure will also work with any dried specimens you may have.

(G) Self Evaluation

1. Plankton are generally microscopic or almost microscopic organisms drifting on the sea's surface waters. Name three major groups.

2. One of the functions of the fish's blood is to exchange gases between it and the body's cells.
   a. What two gases are involved in this exchange?
   b. What organ (other than heart and circulatory system) is closely associated with this gas exchange?

3. What is the relationship between the fish's oxygen consumption and the water temperature?

4. What type of grain makes up the greatest percentage of sand? Describe its appearance.

5. Why do you think the makeup of sand differs on the different beaches of the State?

6. What is the relationship of the size of the common blue mussel to the location where it is growing?

7. Using your data sheet (answer book, page 28), graph the physical properties of water, contrasting the ocean side and the bay side. Make a bar graph, using contrasting shading for the two sides.

8. Identify three types of algae found in the field.

– Career Information Check –

Has your career information been received yet? If so, have you filled out the Career Information Sheet and given it to your teacher? The Marine Career Resource Center should be well on its way by now.

Chapter X: There Are Decisions To Be Made

Chapter Emphasis: The students will research aspects of the laws of the sea, reach well-considered conclusions, and express their decisions. An important by-product is the give-and-take of a group approach to problem solving.

Objectives:

1. Students will be able to define certain problems of the sea.
2. Students will form teams to work toward a solution or decision.
3. Students will be able to use the research tools of the library effectively.
4. Students will take and consult notes on their research problems.
5. Students in groups will appoint a chairman, who will investigate various group techniques for problem-solving.

References:

1. **Speaking By Doing,** William E. Buys, Ph.D. National Textbook Company, Skokie, Illinois 60076. 1967.

Additional references are included in the chapter.

If you would like to try team-teaching on a limited basis, this might be a good chapter to use.

Chapter X: There Are Decisions To Be Made!

There are many major decisions which must be made concerningg the use and ownership of the oceans. Maritime lawyers are very busy with legislation for the next Law of the Seas Conference. Coastal countries, inland countries, navies, coastal fishers, deep-sea fishers, oil companies, mining companies, and environmentalists form some of the pressure groups calling for *decisions* to be made.

You have begun a study of the ocean, its uses and importance to a healthy planet. You are becoming an "informed citizen"! As an informed citizen, *you* have the responsibility to help make decisions.

Within your class there are several ways to bring about decision-making. You could have a formal debate, a panel discussion (which is less formal), or an informal round table or group discussion. You may add other methods of bringing about decision-making.

The first step toward making a decision is, of course, to recognize some . . .

(A) Problems of the Sea

The following is only a partial list of problems of the sea:

1. How far into the oceans should nations claim the sea as *their* territory: 3 miles? 12 miles? 50 miles? 200 miles?

2. Should each coastal state or country have *full* or *limited* control over fishing, navigation, and seabed natural resources within the zone decided upon?

3. Should the coastal states have full or limited control over some or all the species of fish?

4. Should land-locked nations receive any special benefits from the resources of the sea?

5. Who owns and who will have the right to mine the deep seabed of its natural resources, particularly manganese, cobalt, copper, and nickel?

6. Who will determine the standards for pollution-control? Will it be the coastal country or the international community?

We have already noted that, at this writing, Japan and Russia are not abiding by the international treaty to save the whales. So a question arises. How will these international "laws" be enforced?

These are difficult questions. The solutions or lack of solutions may determine the survival of life as we know it on this planet.

(B) Directions for Group Problem-Solving

If you plan to seek solutions to some of the above-mentioned problems . . .

1. Form a group of 4 to 8 students who can work well together.
   Write their names in the spaces provided in the answer book. (10–1)

2. Decide what problem you wish to investigate.

3. Write the problem in specific language. (10–2)

4. Decide what method you will use to reach a conclusion on the problem: formal debate, panel discussion, or round-table (group) discussion, or some other method suggested by your class.

5. Each member of the group must research the problem.
   If you do not know how to use the card catalog, Reader's Guide to Periodical Literature, Education Index, Public Affairs Information Service, and New York Times Index, it may be wise to ask your school librarian to come to your classroom and acquaint you with these research tools.

6. Conferences are in order with your teachers on the best method of note-taking. If you are using cards, remember to put only one major idea on a card. Always note the *source of your information* on the card.

7. Agree with your group members what questions you will seek to answer, or what direction your research will take, such as:

   a. What evidence is there that a problem exists?

b. What bad conditions is this condition or problem causing?

c. What is the extent of the problem? Who is involved?

d. What appears to be the cause of the problem?

e. What will happen if the problem is not solved? What will happen if a decision is not made?

8. Appoint a chairman who will do a good job of conducting the discussion without ruling it. This person has the responsibility of learning how to conduct a panel discussion, round table or group discussion, or a formal debate. The other members of the team will be busy researching the problem.

(C) Resources for Problems of the Sea

The following references may be a help to you to get you started.

GOOD LUCK!

"Deepsea Mining: New Strikes of Hard Minerals Ahead." *Congressional Quarterly Weekly Report,* December 22, 1973. Mining the seabed: who is interested, the UN's role, the U.S. position, and the environmental impact.

Logue, John J., ed., *The Fate of the Oceans.* Villanova, Pa., Villanova University Press, 1972. Preface by Ambassador Pardo and contributions from diplomats and scientists from 12 nations.

Newman, Barry, "Pollution of Oceans Is Enormous Threat, But Few People Care." *The Wall Street Journal,* October 2, 1973. Pollution of the ocean, the causes and possible cures.

Pollution: An International Problem for Fisheries. Rome, UN Food and Agriculture Organization, 1971. Water pollutants, their effects on fisheries, and possible ways to reduce pollution.

Quigg, Philip W., "World Environment Newsletter." *Saturday Review/World.* The newsletter, which appears in each issue of Saturday Review/World, frequently contains information about the oceans and the law of the sea.

Sohn, Louis, *The United Nations and the Oceans.* New York, Commission to Study the Organization of the Peace, 866 UN Plaza, 1973. An authority on world peace through law examines international law and the oceans.

Steele, Robert H., "Trouble in Fishing Waters." *Sierra Club Bulletin,* May 1973. A Connecticut congressman outlines the plight of New England fishermen.

The above references were taken from *Great Decisions, 1975,* published by the Foreign Policy Association. The references below refer to the UN Law of the Sea conferences held in 1976 and 1977.

"The Law of the Sea Conference – A Report by Ambassador T. Vincent Learson." *U.S. Dept. of State Newsletter* #180, June 1976, pp. 8–9.

"The Law of the Sea: A Test of International Cooperation." Address by Secretary of State Henry A. Kissinger. *U.S. Dept. of State Bulletin*, Vol. 74 #1922, April 26, 1976, pp. 533–542.

"U.S. Calls for Equitable Resolution of Law of the Sea Issues." Statement by Secretary Kissinger. *U.S. Dept. of State Bulletin*, Vol. 75 #1946, October 11, 1976, pp. 451–3.

"Sixth Session of Law of Sea Conference Might Prove Decisive." *UN Monthly Chronicle*, Vol. 14 #5, May 1977, pp. 37–38+.

"Third United Nations Conference on the Law of the Sea." *Army Lawyer* #27–50–52, April 1977, pp. 16–17

"New Composite Text To Be Studied by Next Session of Sea Law Conference." *UN Monthly Chronicle*, Vol. 14 #8, August – September 1977, pp. 24–26.

(D) Self Evaluation

1. Did you reach a decision about your problem of the sea in your group? State the conclusion of your group.

2. Were you . . .
   a. Helpful?
   b. Courteous?
   c. Brief and to the point?
   d. A good listener?
   e. Friendly?
   f. Patient?
   g. Sincere?

3. Did you compromise wisely?

4. Were you satisfied with the decision of the group?
   Why or why not?

5. Were you well prepared to contribute good information to your group discussion?

Chapter XI: Art From the Sea and Beach

Chapter Emphasis: The students will view the beach and ocean and life therein with appreciation. Encourage the students to use their creative intelligence and express this in art forms inspired by the sea.

These forms may be poetry; illustrations for poems; science fiction; music; or art forms using clay, papier mache, or objects found on the beach.

Challenge the students' imaginations! Then have the students share their achievements with the rest of the school.

References:

1. *Great Sea Poetry*, Rudyard Kipling and others. Compass Publications, Inc., Arlington, Virginia 22209. 1969.

2. *A History of American Marine Painting*, John Wilmerding. International Marine Publishing Co., 21 Elm Street, Camden, Me. 04843.

3. *Shanties and Sailors Songs*, Stan Hugill. F. A. Praeger, New York, N.Y. 1969.

4. "Gifts You Make," Rubye Graham, from *Seventeen*, November 1974. Triangle Communications, Inc., 320 Park Avenue, New York, N.Y. 10022.

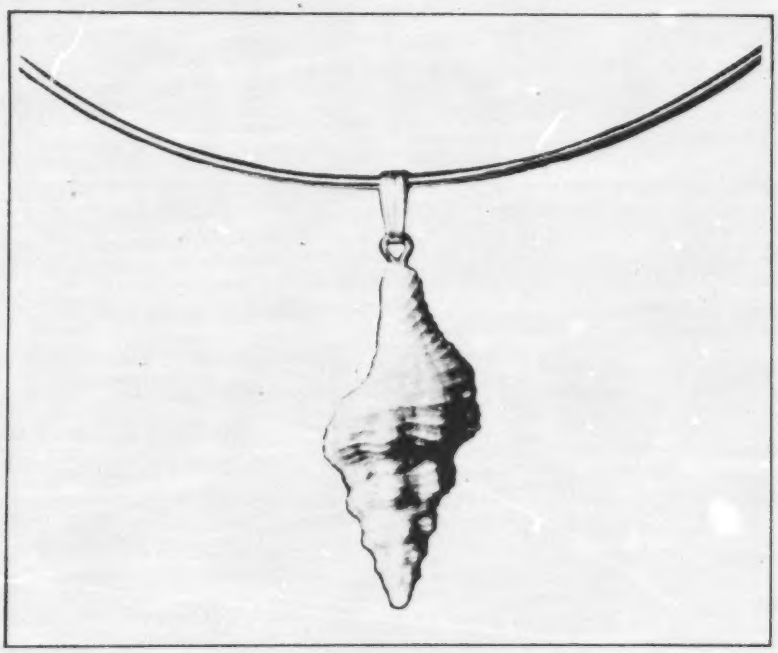
5. *Sand Designing for Terrariums and Aquariums*, Agnes Pamela Miller, T.F.H. Publications, 211 West Sylvania Avenue, P. O. Box 27, Neptune City, N.J. 07753. 1975.

Chapter XI: Art From The Sea And Beach

From earliest times, people have been fascinated by the sea. Both those who make a living on the sea and those who only view it from the shore have been influenced by it. Our music, literature, and art are filled with examples. Before the day of radio and television, those who worked on the ships used music to help them get their work done and to entertain each other. Their art often decorated their ships, using whatever materials were on hand – bits of rope, wood, or the tooth of a whale. Their exploits were recorded in history and fiction. Shipowners frequently hired artists to paint pictures of their ships. Composers and poets tried to capture the sea in poetry and music.

Take a look into your collecting bags. You are a potential artist!

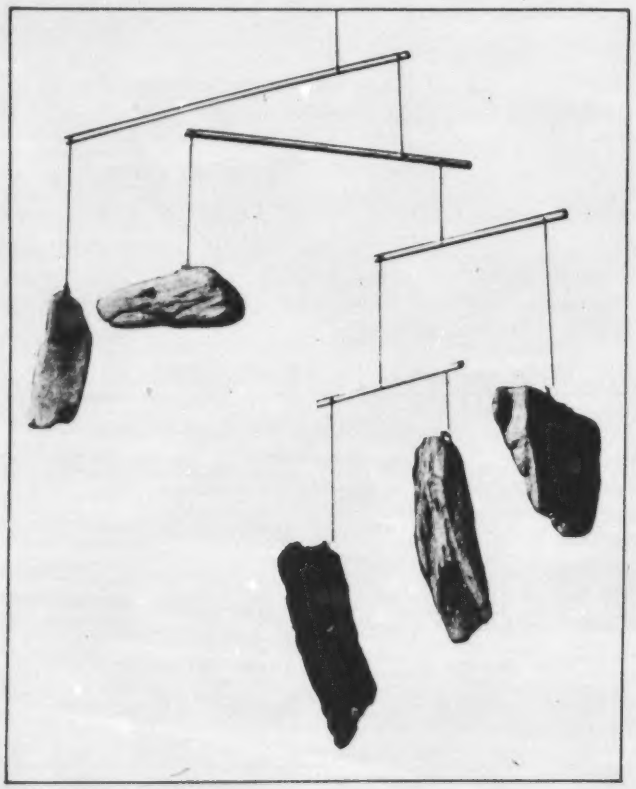
(A) Necklace



You may start with a simple item and yet produce a lovely necklace. Choose a favorite shell; glue an eye-pin onto it. Hang it from a ribbon or a choker band!

(B) Mobile

Do you have some driftwood in your collecting bag? Why not try your hand at making a mobile? Look at the pieces of driftwood. How do they appeal to you? Decide which side is up! Use eye screws to attach the string or line to the pieces of wood dowel. Determine how long you want your strings and then practice a balancing act. Don't give up. It will take some time to achieve the effect you want. If the small dowels are well balanced, they will "float" around in the slightest breeze. Good luck!

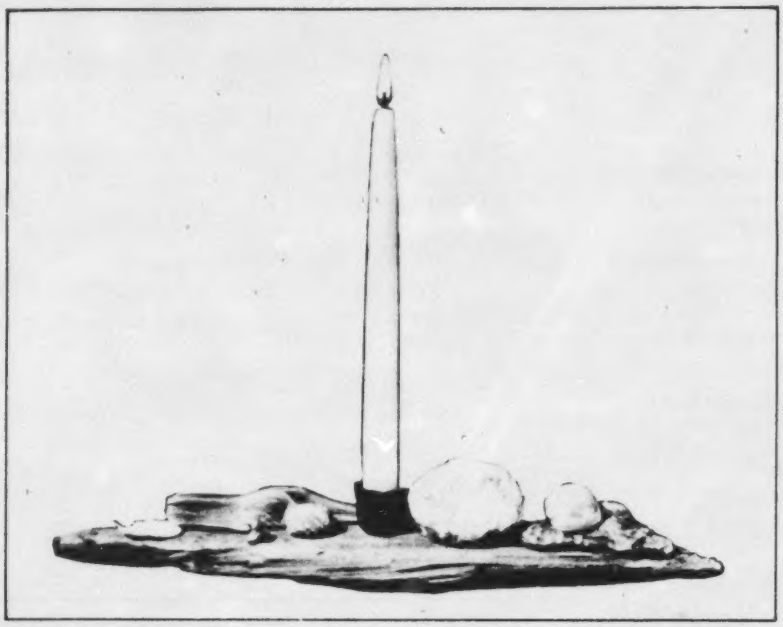


Mobile by Lauren Neuman. Eighth grade, Ocean Township School

(C) Candle Arrangement

Perhaps you have some driftwood, stones, rocks, shells, and even a piece of bark. The following illustration is an arrangement of these. Chain coral shows in the rocks

brought from the shore of Lake Michigan. The shells are from the New Jersey shore area, and the bark from some place in between. The wrought-iron candle holder was purchased, and was screwed into the driftwood. This provides an unusual table decoration.



(D) Plaster Casting

Perhaps you can try your hand at plaster-casting the next time you go to the beach. For an artistic approach, depressions can be made in wet sand which resemble a fish, a clam shell, or any other beach oddity. The depressions can be lined with bits or fragments of sea shells to create a more appealing surface on the finished casts.

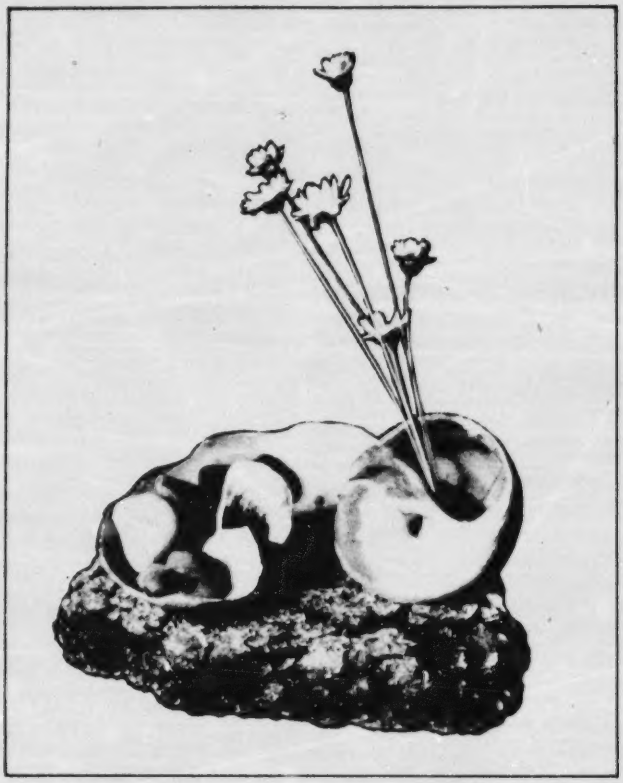
After the plaster of paris has been mixed according to the directions on the package, pour the mixture into each depression. Once hardened, the plaster of paris piece can be removed from the sand and washed to expose the finished surface. If desired, the surface can be painted.

A second approach to plaster-casting permits the collection and identification of animal tracks left on loose or wet sand. When the mixture has dried, a *negative* of the print will be obtained.

(E) Bits and Pieces

You may not have beautiful shells and pretty pieces of driftwood. Broken shells and stones can be assembled in a creative manner (with a little help). The bits and pieces of the art object at right were found on a New Jersey beach, with the exception of the strawflowers.

See what you can do with your bits and pieces. Do any of them suggest animal shapes you?



(F) Knot-Tying

Try your hand at macrame, the art of tying knots to make beautiful or useful objects. Good instruction books are available in most bookstores. In the days of sailing ships the bos'n had to keep the new rope locked up so the sailors wouldn't steal it! After you have mastered some knot-tying, perhaps you could use some shells in your design.

More practical uses of knots could be displayed on a board. The different knots could be labeled and their uses given. Knot tying is still important to sailors today.

(G) Hanging Bowl of Shells

Knot-tying has become increasingly popular to make slings for hanging planters.

Have you ever tried to hang a bowl of shells?

Most of us don't have enough snail shells to string a sling. A fishing line or cord will do.

The center of the bowl is stacked with circular layers of styrofoam. The pieces of styrofoam are held together with toothpicks.

The more decorative shells and animal forms are placed next to the glass.

This would be a particularly good project for one who has traveled and collected many different types of shells, glass and beach oddities.

(H) A Memory Box

Instead of bags of collected items cluttering the bottom of your closet, why not sort them and make a memory box. True, you must use saw, hammer and nails, and glue,

but with some help you will have an object worth exhibiting. The next picture shows a memory box filled with objects collected from a Florida beach. The pieces dividing the box can be designed in any manner appealing to you.

(I) Sand Layering

Sand painting and sand layering are old Indian art forms. Originally natural sand was used, but now colored sand sold in half-pound bags is generally used.

To make your sand-layered potted plant you will need a container, colored sand, one teaspoon, a knitting needle, a small plant, and some sandy soil.

1. Make a simple sketch of the design you want.
2. Begin layering the sand, varying the depth of the layers in different places to make wavy layers.
3. When the container is about two-thirds full, carefully spoon a layer of soil in the center. Fill around the edges with more sand. Continue to layer the soil in the center and the sand around the edges until you get the desired height in your container.
4. Pot your plant by pressing the soil down and away in the center with a spoon. Insert the plant roots into the depression. Push the soil back to cover the roots. Water from the center.

5. Finish with a layer of sand on the top, with possibly some pebbles or gravel sprinkled over the top.

For further instructions for designs in the sand, consult a craft- or florist shop.

* * * * * * * * * * *

To conclude this chapter, "Art From the Sea and Beach," perhaps you would like to read a sea adventure by one of the following authors:

Kenneth Roberts	Edward Rowe Snow
Herman Melville	Jules Verne
Ernest Hemmingway	Thor Heyerdahl
Jack London	Peter Fruchen

Look for examples of American marine painting in an art museum, in the print collection in the library, or in a book on American artists.

APPENDIX

(A) Colleges and Universities Offering Training in Oceanography

University of Alaska
College, Alaska

The American University
Washington, D. C.

Brevard Engineering College
Melbourne, Florida

California Institute of Technology
Pasadena, California

The University of Chicago
Department of the Geophysical Sciences
Chicago, Illinois

Columbia University
New York, N. Y.

University of Connecticut
Storrs, Connecticut

Cornell University
Ithaca, New York

University of Delaware
Department of Biological Sciences
Newark, Delaware

Duke University
Durham, North Carolina

Florida Atlantic University
Department of Ocean Engineering
Boca Raton, Florida

Florida State University
Tallahassee, Florida 32306

Harvard University
Cambridge, Massachusetts

University of Hawaii
Department of Oceanography
Honolulu, Hawaii

Humboldt State College
Arcata, California 95521

University of Houston
Houston, Texas

University of Illinois
Urbana, Illinois 61803

Illinois State College
Chicago, Illinois

The Johns Hopkins University
Department of Oceanography
Baltimore, Maryland 21218

Lehigh University
Bethlehem, Pennsylvania 18015

Long Island University
Brookville, New York 11548

Southampton College of Long Island University
Division of Natural Sciences
Southampton, L.I., New York 11968

Louisana State University
Baton Rouge, Louisiana

Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

University of Miami
Miami, Florida 33149

University of Michigan
Department of Meteorology and Oceanography
Ann Arbor, Michigan 48104

New York University
Department of Oceanography
New York, N.Y. 10453

University of North Carolina
Chapel Hill, N. C.

Northeastern University
Department of Natural Science
Boston, Massachusetts

The Oregon Institute of Marine Biology
Charleston, Oregon

Oregon State University
Department of Oceanography
Corvallis, Oregon

University of the Pacific
Stockton, California 95204

The Pennsylvania State University
University Park, Pennsylvania 16802

University of Pittsburgh
Pittsburgh, Pennsylvania 15213

Pomona College
Claremont, California

University of Puerto Rico
Mayguez, Puerto Rico

Rensselaer Polytechnic Institute
Troy, New York

University of Rhode Island
Graduate School of Oceanography
Kingston, Rhode Island

San Diego State College
San Diego, California 92115

San Jose State College
San Jose, California 95114

Scripps Institution of Oceanography
La Jolla, California 92038

The University of Southern California
Los Angeles, California 90007

State University of New York
Maritime College
Fort Schuyler, New York, N.Y. 10465

Suffolk County Community College
Selden, L.I., New York

Texas A & M University
Department of Oceanography
College Station, Texas

University of Texas
Institute of Marine Science
Fort Arkansas, Texas

Graduate School, U.S. Department of
Agriculture
Washington, D.C. 20250

U.S. Naval Postgraduate School
Monterey, California

Virginia Institute of Marine Science
Gloucester Point, Virginia

Walla Walla College
College Place, Washington

University of Washington
Department of Oceanography
Seattle, Washington 98105

University of Wisconsin
Madison, Wisconsin 53706

Yale University
New Haven, Connecticut 06520

(B) Professional and Trade Organizations Concerned With Marine Science

1. American Littoral Society
   Sandy Hook Marine Laboratory
   Highlands, N.J. 07732

2. Woods Hole Oceanographic Institution
   Woods Hole, Mass. 02543

3. Maritime Academy
   King's Point, Long Island, New York

4. American Society of Limnology and Oceanography
   Institute of Ecology
   University of California
   Davis, California 95616

5. International Oceanographic Foundation
   Room 113, 10 Rickenbacker Causeway
   Virginia Key
   Miami, Florida 33149
   "Training and Careers in Marine Science"

6. Society of Exploration Geophysicists
   P.O. Box 3098
   Tulsa, Oklahoma
   "Careers in Exploration Geophysics"

7. Maine Sardine Council
   P.O. Box 2426
   Augusta, Maine 04330

8. Ecological Society of America
   Department of Botany
   Southern Illinois University
   Carbondale, Illinois 62901

9. Independent Petroleum Association of America
   Information Department
   1101 Sixteenth Street N.W.
   Washington, D. C. 20036

10. National Wildlife Federation
    Educational Servicing
    1412 16th Street N.W.
    Washington, D. C. 20036
    "Employment Opportunities in the Bureau of Sports Fisheries and Wildlife"

11. American Association of Petroleum Geologists
    P. O. Box 979
    Tulsa, Oklahoma 74101

12. Academy of Underwater Photographers
2190 Alston Road
Santa Barbara, California

13. Institute for Navigation
711 14th Street
Washington, D. C. 20005

14. United States Naval Institute
Annapolis, Md. 21402

15. American Institute of Biological Sciences
3900 Wisconsin Avenue N.W.
Washington, D. C. 20005

16. National Ocean Industries Assn.
1100 17Street N.W.
Suite 410
Washington, D. C. 20036

17. American Oceanic Organization
777 14th Street N.W.
Suite 1014
Washington, D. C. 20005

18. International Assn. for the Physical Sciences of the Ocean
Naval Undersea Center
San Diego, California 92132

19. Marine Technological Society
1730 M. Street N. W.
Washington, D. C. 20036

20. American Society of Ichthyologists and Herpetologists
U. S. National Museum — "Career Opportunities for Ichthyologists"
Washington, D. C. 20560

21. American Fisheries Society — "Fisheries as a Profession"
1404 New York Avenue N.W. — (Single copy free)
Washington, D. C. 20005

(C) Government Offices

1. National Oceanic and Atmospheric Administration
   U.S. Department of Commerce
   12231 Wilkins Avenue — "NOAA Career Opportunities"
   Rockville, Maryland 20852

2. U.S. Bureau of Commercial Fisheries
   Fish and Wildlife Service
   Department of the Interior
   Washington, D. C. 20240

3. United States Department of the Interior
   Geological Survey
   Washington Distribution Section — "Marine Geology"
   1200 South Eads Street
   Arlington, Va. 22202 — "What is Oceanography?"

4. Commandant
   U.S. Navy
   Naval district nearest to your school

5. Commandant
   U.S. Coast Guard
   Coast Guard district nearest to your school
   or
   Coast Guard
   Marine Sciences Division
   1300 E. Street N.W.
   Washington, D. C. 20591

6. Naval Research Laboratory
   Ocean Science and Engineering Division
   Washington, D. C. 20390

7. Interagency Committee on Oceanography
   Building 159E
   Washington Navy Yard
   Washington, D. C. 20390

8. Office of Naval Research
   18th and Constitution N.W.
   Washington, D. C. 20360

9. Institute for Environmental Research
   Institute for Oceanography
   8060 13th Street
   Silver Spring, Md. 20910

10. National Science Foundation
    1800 G. Street
    Washington, D. C. 20550

11. National Academy of Sciences
    Committee on Oceanography
    2101 Constitution Ave. N.W.
    Washington, D. C.